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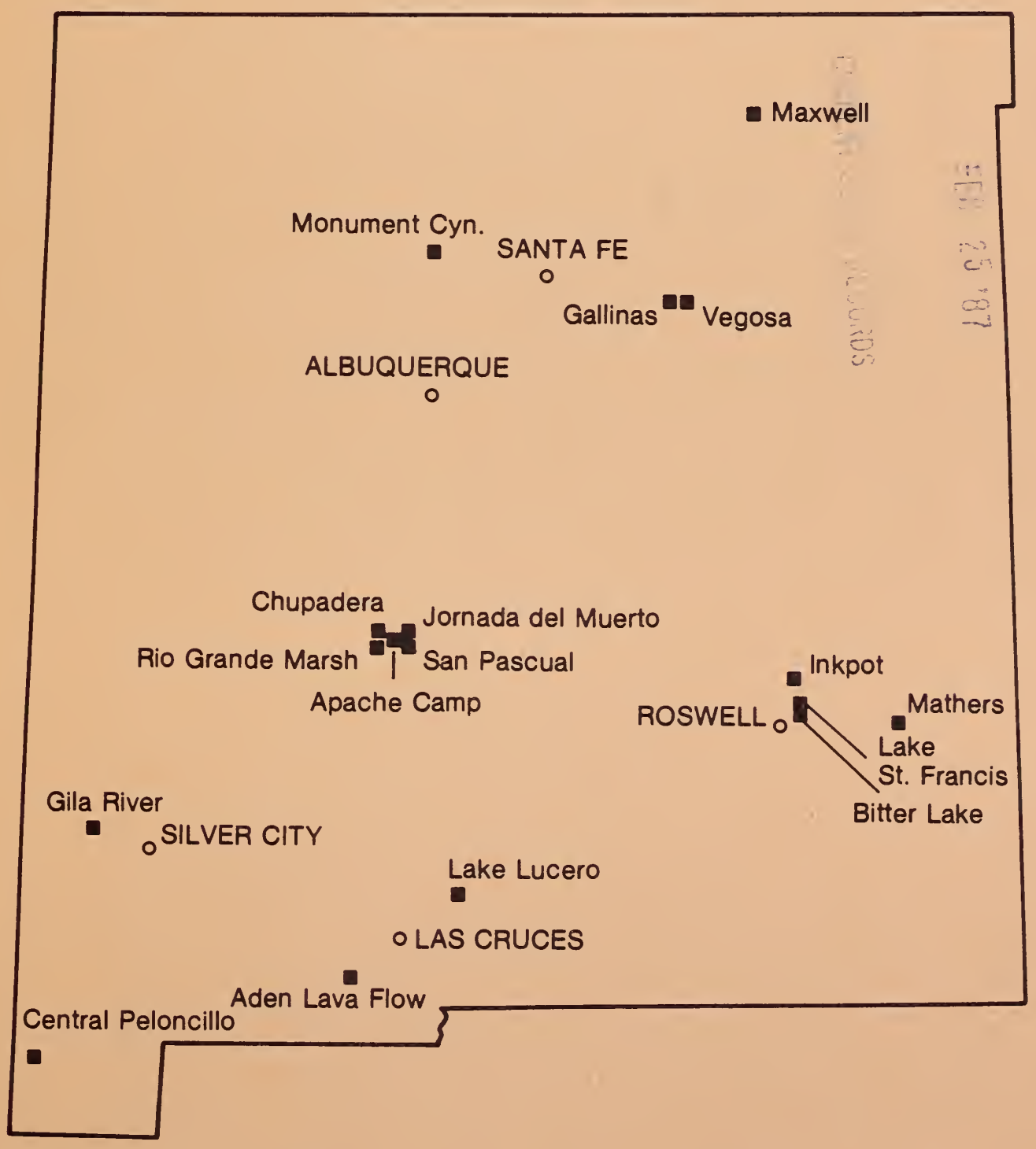
**General Technical
Report RM-136**

Research Natural Areas in New Mexico

Roger S. Peterson and Eric Rasmussen



Abstract

New Mexico's 17 Research Natural Areas are described. Included are maps, photographs, and brief accounts of administration, climate, physiography, geology, soils, vegetation, fauna, research uses, and references. Threats and intrusions are noted. This information should be useful to scientists interested in conducting botanical or zoological research in New Mexico.

Acknowledgments

Patient responders to questions in the USDI Fish and Wildlife Service, Bureau of Land Management, National Park Service, and the USDA Soil Conservation Service made this report possible.

Photographs of four areas were provided by Jerry M. Hoffer (University of Texas—El Paso), John C. Egbert (The Nature Conservancy, Albuquerque), Loren D. Potter (University of New Mexico), and Robert J. Schumerth (White Sands National Monument).

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General Technical Report RM–136

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and

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Contents

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INTRODUCTION

"Research Natural Area" (RNA) is a land management category used by federal agencies since 1927 to designate lands permanently reserved for research and educational purposes. Natural processes are supposed to dominate in these tracts, which preserve some natural features. Principal goals in protecting these lands are:

1. To preserve a representative array of all significant natural ecosystems as sources of baseline data, against which the effects of human activities in similar environments can be measured.
2. To provide sites for studies of natural processes in undisturbed ecosystems.
3. To provide gene pool preserves for plant and animal species, especially rare ones.

In 1977, 4.4 million acres in 46 states and one territory were included in the 389 RNA's in the United States.

Other management categories on federal lands in New Mexico that share some attributes with RNA's are "outstanding natural area," "area of critical environmental concern," "wilderness," "critical wildlife habitat area," "national environmental research park," and "experimental ranch." Even without such titles, some management plans emphasize protection of natural values. An outstanding example in New Mexico is Sevilleta National Wildlife Refuge, in which the acreage reserved for natural and research goals exceeds that of all the designated research natural areas combined. Similarly, much of the area of national parks and monuments is managed mainly for preservation of natural features. This report addresses formally designated Research Natural Areas.

Management and Use

Agencies have developed similar regulations to protect scientific and educational values in Research Natural Areas. Because the guiding principle is to prevent unnatural encroachments, human manipulation is discouraged. In an RNA one expects no construction of buildings, roads, or trails; no grazing by livestock; no woodcutting; and no programs of fire hazard reduction or reforestation. Control of insects, diseases, and fire is permitted to protect adjacent resource values. Public uses, such as picnicking and camping, that might impair natural values are generally discouraged. Policies vary on providing interpretive signs for the public. Hunting and fishing often are not regulated; but, in New Mexico, most RNA's are in refuges or monuments that regulate or prohibit these activities.

Scientists who wish to use an RNA should obtain permission from the appropriate agency. For Central Peloncillo RNA, both agencies listed should be contacted. For Forest Service RNA's, research proposals should go to the Rocky Mountain Forest and Range Experiment Station; but, on-the-ground activities should be coordinated with the National Forest. Scientists should inform the agency of progress, of published results, and of the disposition of any materials collected.

Distribution

As of early 1983, New Mexico has 17 RNA's (table 1). Six are in adjacent pairs and one, although not adjacent, is a 2-acre addendum to a larger RNA (fig. 1). Therefore, effectively, the State has 13 RNA's; but all 17 names are used in this report.

The areas are in 8 of New Mexico's 33 counties. One is in forest, 1 in lava shrubland, 3 in plains steppe or shrubsteppe, 4 in semidesert shrubsteppe, and 8 at lake or river sites.

Most RNA's in New Mexico, like Bitter Lake and Rio Grande Marsh, were designated to protect rare or unique features, rather than to create a system that represents "all significant natural ecosystems." All but one of the RNA's are at relatively low elevations. No alpine tundra nor any of the State's many subalpine forest and meadow ecosystems is included in a natural area. However, the Forest Service proposes to redress some of these deficiencies.

Sources of Information

This report outlines noteworthy features of each Research Natural Area and gives sources for further information. Some of the reference materials are based on studies that were near but not in the RNA's. Several general references, applicable to areas throughout New Mexico, are listed here but are not cited repeatedly through the report. Scientific names of trees, birds, and larger mammals are not usually stated because the common names are fairly standard in familiar manuals.

Introductory material above is in part from the 1977 publication of the Federal Committee on Ecological Reserves, National Science Foundation, "A Directory of Research Natural Areas on Federal Lands of the United States of America." The Directory (p. 142–149) summarizes the (then) 15 Research Natural Areas of New Mexico and prescribes abbreviations for them. This report expands and corrects the Directory's summaries.

Aerial photographs of the areas are available for viewing at appropriate administrative offices and usually also at the nearest Soil Conservation offices, including those in Raton, Silver City, Socorro, and Albuquerque. Aerial imagery may be purchased from the U.S. Geological Survey and, for forest areas, from the U.S. Department of Agriculture. A convenient source from nongovern-

Table 1.—New Mexico Natural Research Areas.

RNA	County	Elevation (feet)	Feature
Aden Lava Flow	Doña Ana	4,300	Lava flow
Apache Camp	Socorro	4,500	Floodplain
Bitter Lake	Chaves	3,500	Playa lake
Central Peloncillo	Hidalgo	5,800	Desert mountains
Chupadera	Socorro	5,500	Desert mountains
Gallinas	San Miguel	6,200	Plains plateau
Gila River	Grant	4,600	River canyon
Inkpot	Chaves	3,600	Sinkhole
Jornada del Muerto	Socorro	4,700	Sand plain
Lake Lucero	Dona Ana	3,900	Desert playa
Lake St. Francis	Chaves	3,500	Sinkholes
Mathers	Chaves	4,200	Sand plain
Maxwell	Colfax	6,000	Playa lake
Monument Canyon	Sandoval	8,200	Mountain plateau
Rio Grande Marsh	Socorro	4,500	Ox-bow lake
San Pascual	Socorro	5,100	Desert mountains
Vegosa	San Miguel	6,500	Plains plateau

ment scientists is the Technology Application Center of the University of New Mexico in Albuquerque.

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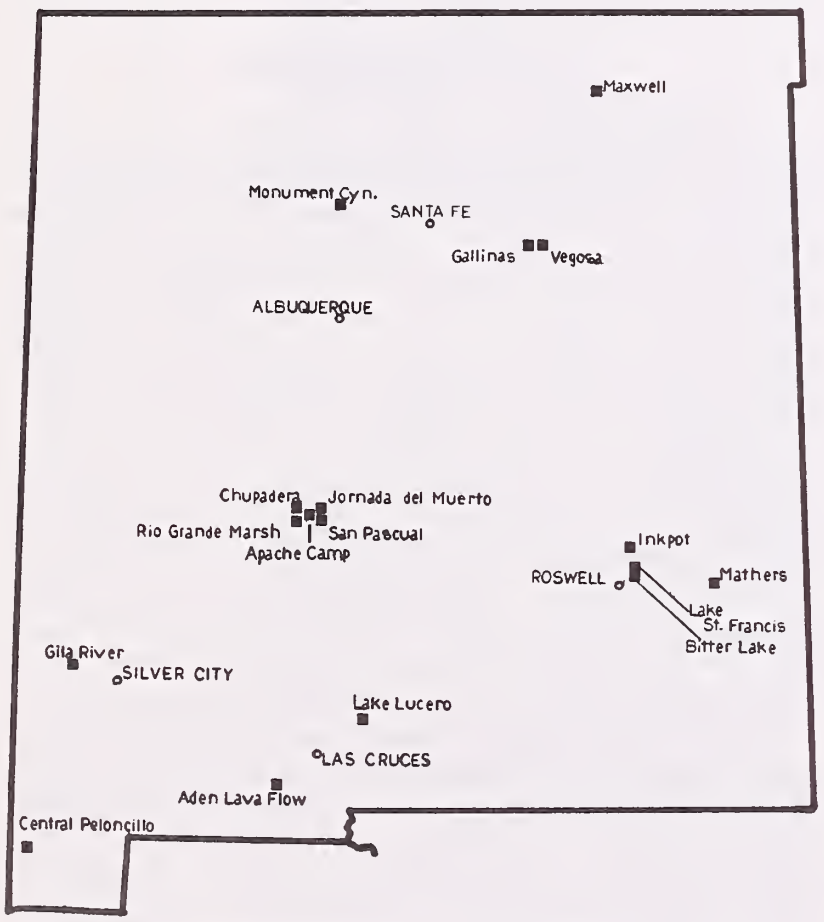

Figure 1. Research Natural Areas in New Mexico.

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USDI—Fish and Wildlife Serv. Endangered species of Arizona and New Mexico. Albuquerque: USDI—Fish & Wildlife Serv.; 1982. 72 p.

ADEN LAVA FLOW RESEARCH NATURAL AREA

The Aden Lava Flow, less than 100,000 years old, consists of basalt flows with a crater, spatter cones, crevasses, ridges, vents, herraduras, and other features covering about 30 square miles of a plain southwest of

Las Cruces. The shrub-grass community of the flow supports a complex array of animal life in this 4,000-acre RNA. Because of the surrounding desert, isolated animal populations of the flow, such as rock pocket mouse and black-tailed rattlesnake, can develop special characteristics.

Administration

Resource Area Manager
Las Cruces/Lordsburg Resource Area
1800 Marquess St.
P.O. Box 1420
Las Cruces, NM 88004 (505) 523–5571

Aden Lava Flow is in the Southern Rio Grande Planning Area. The Las Cruces/Lordsburg Resource Area is part of the Las Cruces District, Bureau of Land Management, U.S. Department of the Interior. The 4,008-acre (1,623-hectare) RNA was designated May 25, 1978, with an acreage correction issued in the Federal Register for November 2, 1978.

The area is open to the public without permit and is open in season for hunting. By an order issued September 23, 1980, off-road vehicles were restricted to designated roads and trails. All mineral rights are federal, and the area is open for mineral leasing. Geothermal leases for the area issued in 1975 have been dropped or have expired.

The 1977 management plan for the natural area called for 14 miles of perimeter fencing, 3 miles of road destruction and reseeding, and 5 interpretive signs. None of this has been done.

Plans called for elimination of livestock from the RNA, which then constituted only a small part of a grazing allotment. In 1981 two pastures, Afton and Malpais, of the original allotment became a separate allotment. The RNA now constitutes about 40% of this 10,000-acre ranch unit. "Because of this and the de-emphasis of the RNA program it is highly unlikely that implementation of the Aden Management Plan will take place" (Harkenrider 1983).

Location and Access

Aden Lava Flow Research Natural Area is in Doña Ana County, centered at lat. 32°04′45″ N., long. 107°02′00″ W., (fig. 2). The 4,008 acres are in T. 25 S., R. 2 W., including all of sec. 34 and 35; in sec. 33 the E1/2 of the NE1/4 and the SE1/4; and in sec. 36 the S1/2: and in T. 26 S., R. 2 W., including in sec. 3 the S1/2 of the N1/2, and the S1/2, and Lots 1–4; in sec. 4 the S1/2 and Lots 5–7 and 9–12; in sec. 5 the SE1/4 and Lots 11–12; in sec. 8 the N1/2 of the NE1/4 and the SE1/4 of the NE1/4; in sec. 9 the N1/2; and in sec. 10 the N1/2.

Access roads within 15 miles of the lava flow are unpaved and can be rough. One route uses the Corralitos exit from Interstate 10 about 2 miles west of Las Cruces; then 16 miles southwest on a county road (BLM #3223) to the locality called Kenzin on the Southern Pacific

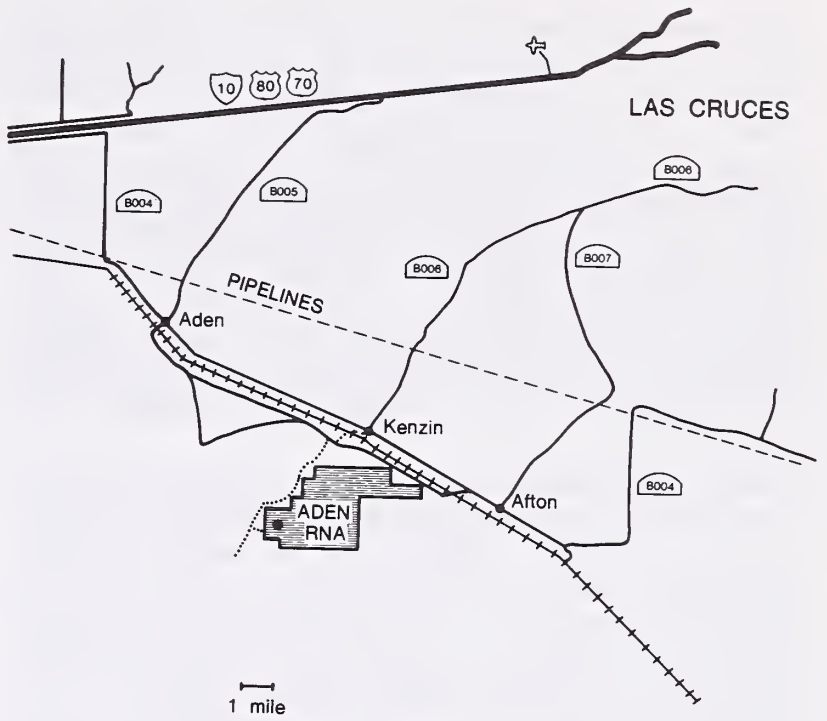

Figure 2. Aden RNA.

Railroad; then across the tracks and southwest for 1.5 miles to the RNA, and another 3 miles skirting its western border till a branch road turns east, into the RNA, to Aden Crater. Turning southeast after crossing the railroad leads to the northeast corner of the RNA.

From Las Cruces one may also cross the Rio Grande on Mesilla Dam Road and continue west for 8 miles to join the above-mentioned county road.

Accommodations are in Las Cruces.

Climate

This is a hot, arid plain, with a mean temperature measured at Las Cruces of 59°F (15°C) and average annual precipitation of 8 inches (203 mm). Monthly average temperature data from New Mexico State University, 19 miles northeast of the RNA (Station 8535), and monthly average precipitation data from near Afton, 6 miles east of the RNA (Station 0125), are shown in figure 3.

The record high temperature 109°F, the low –10°F. Most precipitation comes in summer thundershowers, of which about 42 are expected each year. About 80% of daylight hours are clear. Climate is discussed further by Bulloch and Neher (1980), Malm and Houghton (1977), and by USDI BLM (1975, 1976, 1981).

Physiography, Geology, Soils

This is the Mexican Highland section of the Basin and Range Province. Aden Lava Flow is in the Rio Grande drainage on the La Mesa surface, a relatively flat bolson plain of mid-Pleistocene age, 300–400 feet above the Rio Grande (Hoffer 1975a). Most of the RNA is at about 4,300 feet (1,311 m.) elevation, with depressions somewhat below 4,275 feet (1,379 m.). Microrelief varies from smooth (in the eastern part where the RNA boundary goes north of the lava) to steep-walled fensters that may

be 100 feet wide and 50 feet deep. There are jagged ridges and, where flow patterns allowed for separation of the lava, crevasses nearly 30 feet deep and up to 5 feet wide. Aden Crater, the most prominent feature in the area, is a shield cone (DeHon 1965) 3 to 4 miles in diameter, made up of thin basaltic flows sloping from the cone with dips of 3 to 5°. The rim is composed of spatter layers dipping 30 to 45° toward the center of the crater (fig. 4), (Hoffer 1975b). On the rim are spatter cones, a collapse depression, a 130-foot deep fumarole, and jagged rocks and crevasses. Several explosion craters are southeast of Aden Crater, and near them herraduras (Hoffer 1971) and an hornito.

The lava, which covers 90% of the RNA, was extruded in at least two separate periods, both younger than nearby Afton lava flows that have been dated at 103,000 ± 84,000 years. The low viscosity of this pahoehoe lava is indicated by the fact that some of the lava tubes and tongues are only 6 to 18 inches wide and several hundred feet in length (Hoffer 1975b). Renault (1970) calculates a solidification index of about 40 and infers rapid ascent of the magma. It is thought that the Aden flows were emplaced along fissures associated with the north-south Robledo fault and the northwest-southeast Aden rift, which intersect at or near Aden Crater. The Aden flows are part of the Potrillo basalt field discussed by Hoffer (1976).

A geothermal resource is associated with the volcanism of the area and has attracted commercial attention, but interest has declined because temperature requirements could not be met (Harkenrider 1983, USDI BLM 1975).

Much of the natural area is devoid of soil and classified as Lava Rockland. Pockets of soil are Torriorthents, and range from thin layers to several feet in depth on about a fourth of the landscape (Bulloch and Neher 1980). Simona-Harrisburg Association soils occupy the non-lava segment of the RNA.

Vegetation

At least 23 shrub species are conspicuous on the lava, including prominently creosotebush (*Larrea*), snakeweed (*Gutierrezia*), yucca (*Yucca baccata*), jointfir (*Ephedra*

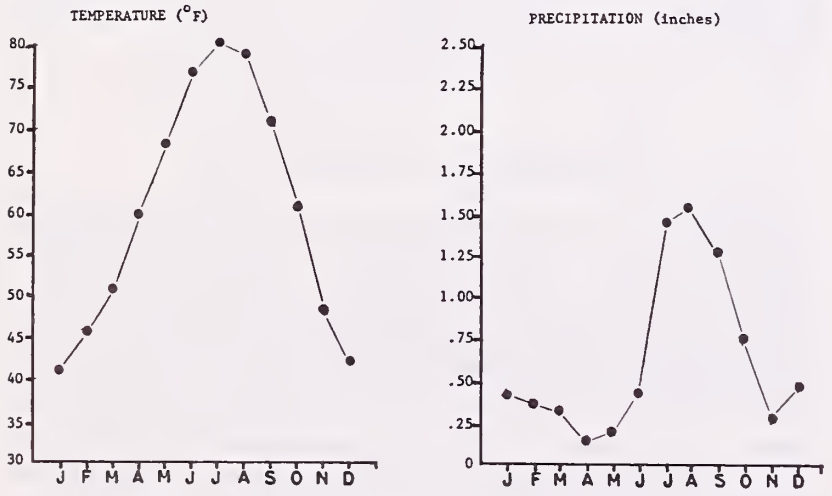

Figure 3. Climate of Aden Lava Flow RNA.

Figure 4. Aden Crater from the northeast. Aden Lava Flow RNA. (From Hoffer 1976, courtesy of J. M. Hoffer.)

trifurca), saltbush (*Atriplex canescens*), and tarbush (*Flourensia cernua*), with a scattering of juniper (*Juniperus monosperma*). Common grasses include tobosa (*Hilaria mutica*), black grama (*Bouteloua eriopoda*), sideoats grama (*B. curtipendula*), hairy grama (*B. hirsuta*), mesa dropseed (*Sporobolus flexuosus*), bush muhly (*Muhlenbergia porteri*), and fluffgrass (*Erioneuron pulchellum*) (fig. 5). Off the lava, mesquite (*Prosopis glandulosa*), soap tree (*Yucca elata*) and snakeweed dominate. Species lists based on collections by T. Van Devender and others are in USDI BLM (1976), as is a short list of lichens.

Animals

M. McKirnerey and W. H. Reid compiled a list of 48 mammal species that are probably in the area (USDI BLM 1976), including 9 rodent species studied here by Koschmann (1972) and 14 other species sighted in the vicinity of Aden Crater. Common are desert cottontail, black-tailed jackrabbit, coyote, and California myotis; as many as 12 bat species are expected because of the many crevices and small caves. Ten carnivore species are listed, including sightings of coyote, gray fox, ringtail, western spotted and striped skunks, and bobcat. Mule deer and pronghorn occur but are uncommon.

Some rodents in the lava flow show melanistic changes, in particular the rock pocket mouse (*Perognathus intermedius*). Benson (1933) and Koschmann (1972) have studied these dark races.

McKirnerey and Reid (in USDI BLM 1976) list 38 bird species for the lava flow, including 10 raptor species. Turkey vultures nest in vent tubes southeast of Aden Crater.

The environmental analysis record (USDI BLM 1976) also includes lists of reptiles and amphibians, but the occurrences are mainly speculative rather than confirmed. Melanistic black-tailed rattlesnakes have been studied on the flow (Prieto and Jacobson 1968).

A well-preserved Shasta ground sloth was found in the deep fumarole of Aden Crater (Lull 1929) and has been dated about 11,000 years before the present (Simons and Alexander 1964).

Intrusions and Threats

A north-south fence crosses section 35, and a trail open to off-road vehicles meets it from the northeast. A 2-track road from the west reaches the rim of Aden Crater. Sightseers and their vehicles might be counted as intrusions, and the Southern Pacific railway, though 0.25 miles or more north of the natural area, surely seems to be one.

The area was leased for geothermal production in 1975, but there was no development. The leases have terminated; however, the area has not been withdrawn from leasing as BLM planned.

Cattle, past and present, are probably the main intrusion. The vegetation shows signs of past overgrazing. The plan to eliminate grazing has been shelved, and in fact made difficult by realignment of grazing allotments. About 2.5 cattle yearlong are permitted per 640-acre section in the allotment. The proposed allocation of federal grazing capacity of the allotment is 227 animal unit months for livestock and none for big game, increasing by the year 2019 to 338 for livestock and none for big game (USDI BLM 1981).

Research

Considerable research has been and is being done in the area, much of it by faculty of the University of Texas—El Paso, in geology (Hoffer, 1971, 1975a, 1975b) and in biology. USDI BLM (1976) mentions ongoing research on behavior of carnivores, Townsend's big-eared bat, and Pleistocene faunal sites. Chaves (1983) is working on topographic and edaphic relations of vegetation on the flow. Sources below report additional geological work near Aden Crater.

Maps

Topographic: U.S. Geological Survey 1:62,500 series, Aden Quadrangle, 1941, and, for the easternmost 160 acres, Afton Quadrangle, 1941. Geological: Hoffer (1975b, 1976) and Kottlowski (1953). Vegetation: maps such as that in USDI BLM (1975b) merely differentiate malpais vegetation from non-malpais. Soils: Bulloch and Neher (1980). Aerial photography: Bulloch and Neher (1980).

Figure 5. A crater rim and typical vegetation. Aden Lava Flow RNA.

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APACHE CAMP RESEARCH NATURAL AREA

This strip of Rio Grande riparian vegetation, 3 miles long and less than 1,000 feet wide, suffers take-over by saltcedar and drowning by water backed up from a channelization project. It provides waterfowl, raptor, songbird, and mule deer habitat. Cottonwood dominates "upland" (8 feet above "lowland") parts of the area, with saltcedar and saltgrass or sacaton understories.

Administration

Refuge Manager
Bosque del Apache National Wildlife Refuge
P.O. Box 1246
Socorro, NM 87801 (505) 835–1828

Apache Camp is one of the 5 natural areas in Bosque del Apache Refuge, a 57,191-acre unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1939. These "220 acres" (89 hectares; but in fact probably closer to 260 acres—105 hectares—with the given boundaries) were designated a Research Natural Area August 17, 1973.

Public access is allowed during daylight hours. Mule deer hunts with primitive weapons are allowed in this part of the Refuge in some years. No livestock grazing is permitted on the Refuge. This is New Mexico's only RNA with public facilities: toilets are maintained by the tour loop road in the north end of the area. The RNA is neither fenced nor posted.

Location and Access

Apache Camp RNA is in Socorro County, centered at lat. 33°48′40″ N., long. 106°51′30″ W., (fig. 6). Were the area surveyed it would be in T6S R1E. The RNA extends north along the Bosque del Apache Wildlife Refuge tour loop road for 3 miles from its junction with the road that crosses the Rio Grande Main Conveyance Channel. At that southern end the RNA is 480 feet wide, widening northward to 900 feet, which is nearly constant for most of the length of the RNA. West and south boundaries are graded roads. The east boundary is a 2-track road along the west side of the Conveyance Channel; it is gated, locked, and at least during 1981–1982 was partly under water. The north boundary is a revegetating road and dike from the northern extremity of the tour loop to the Conveyance Channel.

Apache Camp is 88 miles from Albuquerque and 137 miles north of Las Cruces. From the north, turn off Interstate 25 on US 380 for San Antonio (10 miles south of Socorro); from the town of San Antonio follow Refuge signs 8 miles south on N.M. 1 to headquarters of Bosque del Apache refuge. From the south turn off I–25 for San Marcial and follow N.M. 1 north for 12 miles to Refuge headquarters. From headquarters turn east (open only during daylight hours) and head as nearly as possible east on tour loop roads for 1.35 miles, where this two-way segment of tour loop road system ends at the southwest corner of the RNA. The length of the RNA may be driven on either east or (better) west side.

Accommodations are in Socorro.

Climate

This is a warm region with arid climate (Campbell and Dick-Peddie 1964; Houghton 1972). Precipitation averages 8 inches (200 mm.) annually, very little of it snow. July through September account for 47–60% of the precipitation. Mean temperature is 58°F (14°C); the highest temperature recorded was 113°F (45°C) and the lowest –9°F (–23°C). Monthly averages from the weather station at Refuge headquarters (Station Index 1138), 1.5 miles west of and a few feet above the RNA are shown in figure 7.

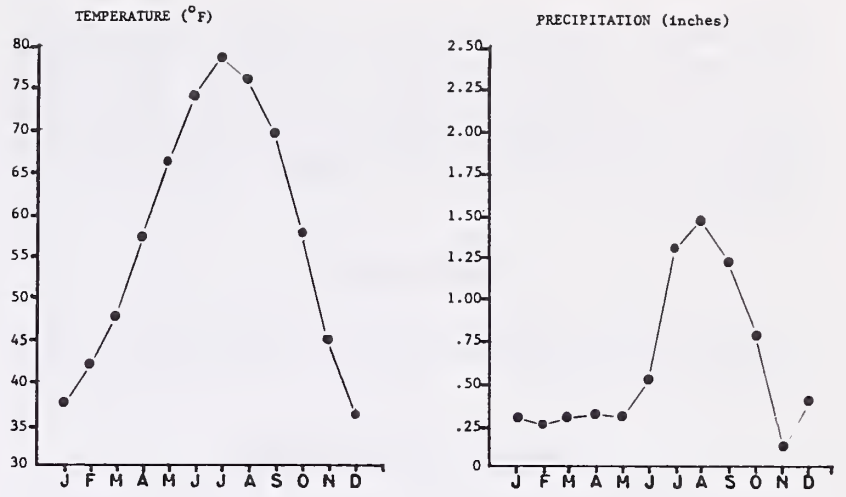

Figure 7. Climate of Apache Camp RNA.

Physiography, Geology, Soils

Apache Camp RNA is in the floodplain of the Rio Grande, which here traverses the Basin and Range Province through a rift valley (Hawley 1978). In 1929 the river flowed across the southern part of what is now the RNA, and an oxbow lake lay farther north within the area (Poulsen and Fitzpatrick 1931). Small banks and marshes remain as witnesses to these vicissitudes. Now the river is thought to have been tamed; a straight channel lies along the east side of the RNA. In 1981–1982 work on that channel downstream backed water onto the southern quarter of the RNA; saltcedar and ducks are the principal survivors.

The Rio Grande used to go dry frequently here; for instance an average of 39 days per year during 1916–1927 (Poulsen and Fitzpatrick 1931). The natural channel still goes dry, but flow is relatively steady in the Main Conveyance Channel, 10 feet east of the Apache Camp RNA boundary.

Elevations range from the southern water level at about 4,508 feet (1,374 m.) to banks reaching 4,516 feet (1,377 m.) at the north end.

Recent river deposits cover the area, and soils, if any, are young. Maker et al. (1972) classify soils of the floodplain—an entisol bottomland—in the Gila-Vinton-Glendale Association. The RNA appears to have mainly alkaline (Gila?) clay and silt. The soil regime is thermic; great groups represented are Torrifluvents, Calciorthids, and Torriorthents.

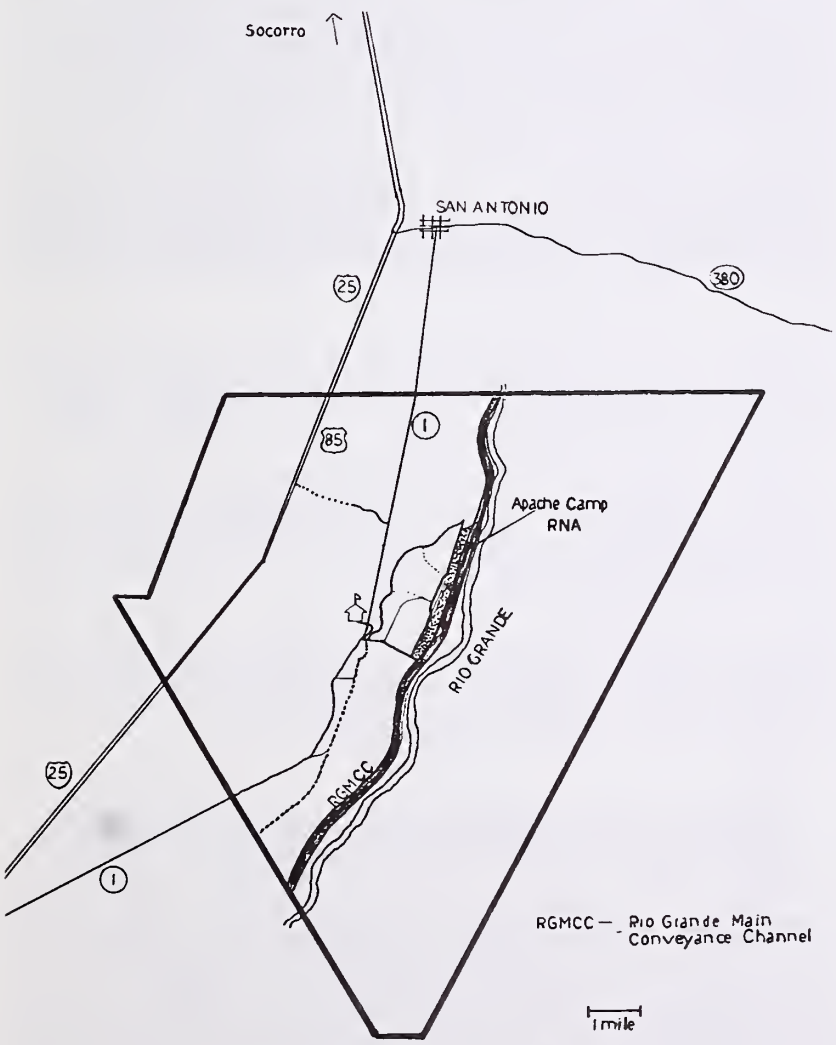

Figure 6. Apache Camp RNA.

Vegetation

Evidence suggests that Rio Grande cottonwoods (*Populus fremontii* var. *wislizenii*) dominated this area some decades ago, and they still dominate parts of it (fig. 8). However, fire (mostly recently in 1978) and the invasion of saltcedar (*Tamarix gallica*), beginning mainly in the 1940's, have taken a heavy toll. The southern end of the RNA, under water in 1981–1982, has only saltcedar and a few aquatic and marsh plants (fig. 9). Northward are varying mixes of cottonwood and saltcedar with scattered tornillo (*Prosopis pubescens*), black or Goodding willow (*Salix nigra* including *S. gooddingii*) and Russian olive (*Eleagnus angustifolia*), the last, like saltcedar, a Eurasian species. Low shrubs include wolfberry (*Lycium*) and coyote willow (*Salix exigua*). Prominent grasses are alkali sacaton (*Sporobolus airoides*) and saltgrass (*Distlichis spicata*), with some three-awn (*Aristida longiseta*). But much of the ground is bare under the tree-shrub layers.

A few seasonally dry depressions support wetland vegetation, notably cattails (*Typha*), saltgrass, and rabbitfoot grass (*Polypogon monspeliensis*).

The potential natural vegetation is Forest Cover Type 235, cottonwood-willow (Eyre 1980). Campbell and Dick-Peddie (1964) discuss riparian communities of this area.

Animals

Many birds nest or feed here, including (so long as part of the RNA is flooded) waterfowl and wading birds.

Mourning doves are common. The large cottonwoods are home to songbirds and raptors (USDI—FWS 1982).

Mule deer, rock squirrels, and whiptail lizards are among the conspicuous animals. No doubt there is a diversity of amphibians and reptiles, but data are not available.

Archaeology

The immediate vicinity is known as an Apache camping area.

Intrusions and Threats

Intrusions appear to outnumber natural features. Dikes, canals, and roads surround the area. Four-foot-high dikes poke into it from both sides, and there are piles of earth from the canal on the east side. Introduced saltcedar is by far the most common woody plant here, abetted by man-caused flooding. Public toilets were built in the area the year it was designated an RNA.

Research

None is known for the RNA.

Maps

Administrative: consult Refuge headquarters. Topographic: USDI—Geological Survey 1:24,000 series, San Antonio SE Quadrangle, 1982. Soils: Poulsen and Fitzpatrick (1931); Maker et al. (1972). Geology: Bachman and Stotelmeyer (1967). For aerial photography consult the Refuge management or the Soil Conservation Service office in Socorro.

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Figure 8. Cottonwoods above saltcedar and cattails. Apache Camp RNA.

Figure 9. Inundated saltcedar. Apache Camp RNA.

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BITTER LAKE RESEARCH NATURAL AREA

Bitter Lake—or, by late summer, the dry, white Bitter Lake playa—covers half of the natural area's 300 acres. In winter, large numbers of waterfowl, sandhill cranes, and migratory shorebirds inhabit the lake, and several shorebird species remain year-round. In gypsum beds west of the lake, springs and small, brackish streams flow

through sinkholes inhabited by three uncommon minnows: Pecos gambusia, greenthroat darter, and Pecos pupfish.

Administration

Refuge Manager
Bitter Lake National Wildlife Refuge
P.O. Box 7
Roswell, NM 88201 (505) 622–6755

The Refuge is a unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1937. Bitter Lake Research Natural Area was designated 17 August 1973. It comprises about 300 acres (121 hectares). Entry requires a permit from the Refuge Manager except to the observation platform at the southwest corner of the natural area. Hunting, fishing, and livestock grazing are prohibited. Mineral rights in the RNA are federally owned, but this is not true for Section 32, 0.3 miles north of the RNA. The research natural area is not marked as such, but there are "no unauthorized entry" signs at strategic points.

Location and Access

Bitter Lake Research Natural Area is in Chaves County, centered at lat. 33°28′20″ N., long. 104°24′30″ W., in T. 10 S., R. 25 E., secs. 4 and 5, (fig. 10). Beginning at the intersection of a Refuge road with No. 2 Impoundment in the SW1/4 of the NE1/4 of sec. 4, the boundary is described as S 15° W for 1,000 feet, thence S. 37° E. for 1,750 feet, thence S. 41° W. for 600 feet, thence W. for 4,200 feet, thence N. for 2,850 feet, thence E. for 3,800 feet to point of beginning.

The RNA is a mile north-northwest of headquarters in the south tract of Bitter Lake National Wildlife Refuge,

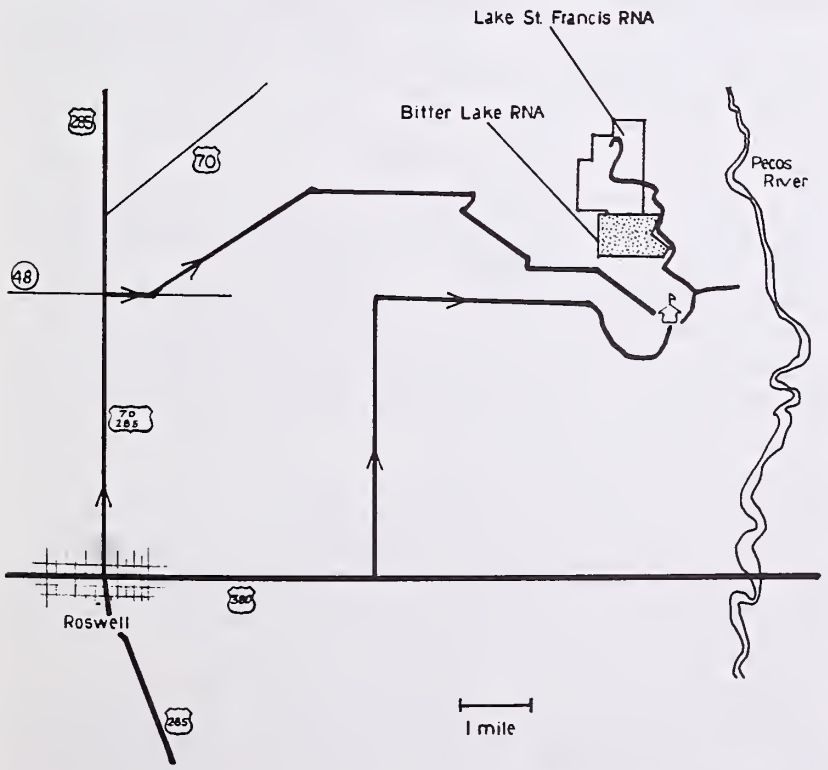

Figure 10. Bitter Lake RNA.

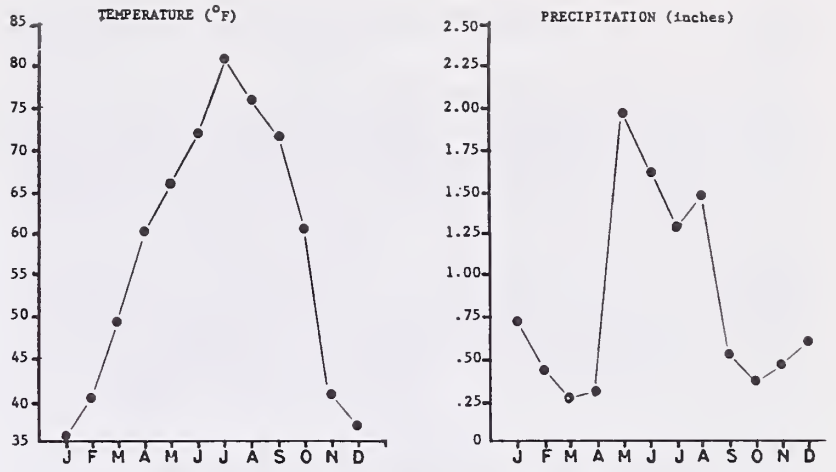

Figure 11. Climate of Bitter Lake RNA.

14 miles northeast of Roswell. From Roswell or from the east a road leading to the Refuge turns north from U.S. 380, 3.8 miles east of Main Street. From Roswell or from the north a road leading to the Refuge turns east from U.S. 70–285 (= Main Street) 4 miles north from U.S. 380 (= Second Street); follow Refuge signs as the route turns northeast after 0.6 miles, then east again after another 2.4 miles.

Given an entrance permit, the southwest corner of the natural area can be reached by car from the west entrance road. East, north, and west sides of the RNA are reached by a road through the headquarters area.

Accommodations are in Roswell.

Climate

The Refuge is in a warm desertic region, with mean temperature 58°F (14°C) and average precipitation 10 inches (250 mm.) per year measured at the Refuge, or 13 inches (330 mm.) per year measured over a longer period near Roswell. Sunshine averages 70% of the amount possible for the year. The record high temperature at the Refuge is 112°F (44°C) and the low –12°F (–24°C). Climate is discussed by Houghton (p. 138–141 in Hodson et al. 1980) and by Mourant (1963). Monthly averages from Refuge headquarters (Station Index 0992), 1 mile from the RNA are shown in figure 11.

Physiography, Geology, Soils

Bitter Lake is in the Pecos Valley section of the Great Plains Province, in the west edge of the floodplain of the Pecos River. The river's present channel is 1.25 miles to the east; a former channel with impoundments for waterfowl is adjacent to the RNA.

Only 10 feet separate high and low elevations in the natural area, 3,501 and 3,491 feet (1,067 and 1,064 m.). Depth of the playa lake that covers about half the RNA varies from 0 in later summer and fall to (theoretically) 4 feet. Excess over 4 feet would flow out through a spillway, but that depth has not been achieved in many years. Bitter Lake receives water from streams and springs on its west side. Of several small sinkholes there, a few contain water. The playa basin is said to be the result of sub-

sidence a few decades ago caused by an underground stream.

The uppermost strata covering the natural area are Pleistocene and Recent alluvium, including terrace gravel and disturbed gravel. Thickness of this valley fill—all of it water-saturated, according to 1969 data—is about 150 feet (Lyford 1973). Bedrock, exposed at sinkholes and streams, is a gypsiferous layer of the Queen Formation, part of the Permian Artesia Group (Kelley 1971). The sinkholes contain superficial gypsite deposits. Water levels depend on recharge in the Roswell Artesian Basin, which in turn depends upon precipitation and water-use many miles to the west and south.

Soils are alkaline from solution of gypsum; the 150-acre lake bed is covered by a gypsum crust. Soils are characterized for the most part as shallow, pale-brown loams with a thick solum at the A2 level and high gypsum content. They are in the Holloman-Gypsumland complex, classified as Gypsiorthids and Torriorthents (Hodson et al. 1980). The moisture regime is borderline between aridic and ustic-aridic.

Vegetation

Plants must be gypsum-tolerant to grow here; a few such as gyp ring-stem (*Anulocaulis gypsogenus*) are obligate gypsophiles. On the gypsum deposits at the edge of the playa grows a vigorous stand of seepweed (*Suaeda* sp.) with sea lavender (*Limonium limbatum*), glassworts (*Salicornia* spp.) and iodinebush (*Allenrolfea occidentalis*).

On the west side of the lake where water enters is a bulrush-cattail marsh in which the tallest species, three-square (*Scirpus americanus*), is 5 or 6 feet tall (fig. 12). Marsh vegetation continues west from the shore in the wetter areas, grading into reeds (*Phragmites australis*) where there is no standing water. In the water are stoneworts or muskgrass (*Chara*), ditchgrass (*Ruppia maritima*), arrowgrass (*Triglochin maritima*) and pondweed (*Potamogeton pectinatus*). Beside the small streams grow a variety of grasses such as saltgrass (*Distlichis spicata*) and alkali muhly (*Muhlenbergia asperifolia*) and herbs such as prairie gentian (*Eustoma exaltatum*) (fig. 13). Saltcedar (*Tamarix*) has invaded since a 1937

Figure 12. Bulrushes at the west end of mostly-dry Bitter Lake.

Figure 13. Saltgrass and shrubs at the playa's edge, with reeds and salt cedar in the background. Bitter Lake RNA.

survey (Campbell 1937), and is found scattered near most shores of Bitter Lake and near sinks and streams.

Away from the water sacaton (*Sporobulus* spp.), gramas (*Bouteloua* spp.), and other grasses dominate, but with many herbs such as *Sartwellia flaveriae* and low shrubs such as *Clappia suaedifolia*. For this upland vegetation see also discussion of the adjacent Lake St. Francis RNA.

Animals

Bitter Lake Refuge is the most important waterfowl concentration point in eastern New Mexico, and water birds use Bitter Lake in abundance. Almost 300 bird species have been recorded at the Refuge (USDI—Fish & Wildlife Serv. 1976, Hubbard 1978), of which the chief lake-users are Canada goose, snow goose, mallard, gadwall, blue-winged teal, wigeon, shoveler, ruddy duck, coot, lesser sandhill crane, ring-billed gull, herons, and snowy egret. The locality is especially important for the lesser sandhill crane, of which 70,000 have been counted at one time on Refuge roosts. Their presence peaks in October-December. Shorebirds that nest here include snowy plover, killdeer, avocet, and black-necked stilt.

Three minnow species inhabit the springs and sinks west of Bitter Lake; all three are in the sink fed by Sago Spring, and various combinations of species are in the other waters (Hubbs and Echelle 1972). The Pecos gambusia (*Gambusia nobilis*) is listed as endangered by the Fish and Wildlife Service and as threatened by the New Mexico State Game Commission; the greenthroat darter (*Etheostoma lepidum*) is listed as endangered by the state; and the Pecos pupfish (*Cyprinodon pecosensis*), though no longer listed as threatened, is also a species of restricted and rather uncertain Pecos Basin habitats (Bednarz 1975, Echelle and Echelle 1978, Hubbard et al. 1979, Hubbs and Echelle 1972). Micro-distributions of the minnows in the Refuge ponds have been affected by transplant experiments in 1973 and 1981.

Desert cottontail, black-tailed jackrabbit, striped skunk, raccoon, bobcat, coyote, gray fox, badger, and long-tailed weasel are among the mammals noted for this part of the Refuge (USDI—Fish & Wildlife Serv. 1976).

Invertebrates have been studied in a sulphate-rich springbrook near Roswell, similar to those of Bitter Lake RNA (Noel 1954).

Intrusions and Threats

Gravel roads reach into the RNA on the west, southwest, south, and north; but the latter two, formerly connecting across the middle of the playa, have largely been destroyed by water. Roads are maintained just outside the east and northwest boundaries of the natural area, and a parking area and observation platform are at the southwest corner. The east roadbed would serve as a dike at high water levels.

A ditch at the southeast corner would drain the lake were the depth to exceed 4 feet, since water beyond that depth is not federally owned; but there has been no flow since the ditch was dug.

Saltcedar, Russian olive, and other Eurasian plant species might also be regarded as intrusions.

Principal threat to the natural area is the decline of the watertable in the Roswell Artesian Basin in which Bitter Lake is located. Some of the small sinkholes in the west part of the RNA have dried up, and flow from springs and from Lost River, the small stream that enters the area from the west, have decreased over the years. The problem is discussed under Lake St. Francis Research Natural Area.

Research

Recent study of the minnows has been sponsored by the New Mexico Department of Game and Fish, and has also been carried out by academics including the Echelles (1978) of Baylor University and Hubbs (1972) of the University of Texas. Management research on lesser sandhill cranes is carried out here by the Department of Game and Fish.

Maps

Administrative: consult Bitter Lake National Wildlife Refuge. Topographic: U.S. Geological Survey 1:24,000 series, Bitter Lake Quadrangle, 1962; 1:100,000 series, Roswell sheet, 1979. Vegetation: Campbell (1937). Geology: Kelley (1971). Soils: Hodson et al. (1980). For aerial photography see Hodson et al. (1980).

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CENTRAL PELONCILLO RESEARCH NATURAL AREA

Sierra Madrean animal and plant species, many at or near their northeastern limits, here inhabit the rugged Peloncillo Mountains. Piedmont desert grassland, Madrean oak woodland, interior chaparral, and pinyon-juniper woodland lightly clothe rocky slopes that rise from 5,200 to 6,500 feet in elevation within the natural area. Large mammals include mule deer and Coues' white-tailed deer, javelina, feral swine, gray fox, black bear, coati, mountain lion, and bobcat. A rich reptile fauna is present, and a well-studied bird fauna of about 150 recorded species. Soils and geology—Miocene tuffs and rhyolite-welded tuffs—are also relatively well-known in the 4,348-acre RNA.

Administration

Area Manager
Las Cruces/Lordsburg Resource Area
Bureau of Land Management
P.O. Box 1420
Las Cruces, NM 88004 (505) 523–5571
and
Dr. Robert T. Scholes
Bioresearch Ranch, Inc.
P.O. Box 117
Rodeo, NM 88056 (602) 558–2330

Uniquely among New Mexico's Research Natural Areas, Central Peloncillo takes advantage of a provision in the Standards and Policy Guidelines for Research Natural Areas (Federal Committee on Ecological Reserves, 1976, Selection Criteria 2.3.1) permitting designation of private land in conjunction with a federal RNA. The federal grazing allotment that is tied to what is now Bioresearch Ranch was, at Dr. and Mrs. Scholes' instigation, retired. Designation of the area (Federal Register 2 October 1980) formally lists only the 2,468 federal acres but states that "The selection of nonuse of the grazing privileges by the base property owner and his desire to continue this practice has created an area that is essentially a giant control plot for an outdoor laboratory. This area of special worth must be protected." The Bureau issued a Central Peloncillo Research Natural Area Research Use and Management Master Plan in 1979, and concepts from it are included in the Plan Element (USDI BLM 1980) promulgated prior to designation. It calls for joint approval of prospective research by Bureau and Bioresearch Ranch and outlines permitted educational and recreational uses. Off-road vehicles, picnicking, camping, and collection are among prohibited uses. "If land or mineral interest becomes a threat, withdrawal action with subsequent segregative effects should be considered." The Bureau's district animal damage control plan establishes a buffer zone of at least 6 miles around the area to limit effects of predator trapping.

A cooperative agreement between the Bureau and Bioresearch Ranch was signed September 9, 1980, and is used in lieu of the pending joint management plan.

Lack of agreement between regulations governing designation of RNA's and the Federal Land Policy and Management Act of 1975 caused a bureaucratic quirk: this research area is technically not an RNA but an "area of critical environmental concern" *named* "Central Peloncillo Research Natural Area." No significant distinction exists, according to the BLM's State Director.

The RNA is fenced and livestock grazing has not occurred since 1972. Hunting, in season, is permitted on the public lands because of strenuous objections by the New Mexico Department of Game and Fish to the initial, 1977, closure of the area to hunting by the Bureau. Access is controlled by the private landowners.

In 1982, The Nature Conservancy acquired, through gifts, 2,010 acres of the Owl Canyon drainage north of Bioresearch Ranch. By cooperative agreement signed in December 1982 the Bureau has leased grazing privileges (which will not be used) on 620 acres of federal land in Owl Canyon to the Conservancy. For most purposes these 2,630 acres may be thought of as additions to Central Peloncillo RNA, though as of January 1983 the Bureau's Area Manager had no plans to include Owl Canyon in the RNA. For further information consult John C. Egbert, Field Office Director, The Nature Conservancy, P.O. Box 1846, Albuquerque, NM 88103; (505) 242–2015.

Location and Access

Central Peloncillo Research Natural Area is in southwestern Hidalgo County about 9 miles southeast of Rodeo (fig. 14). It is centered at lat. 31°43′5″ N., long. 108°56′45″ W. The RNA is in T. 30 S., R. 21 W., including all of sec. 1–2 and 10–12 and parts of sec. 3 and 9; and T. 30 S., R. 20 W., parts of sec. 6–7 and 18.

At this writing there is no public right-of-way. Visits should, in any event, be arranged in advance with the Bioresearch Ranch, which has headquarters at the RNA. The Ranch entrance is an east turn from U.S. 80 5.5 miles southwest of Rodeo onto a dirt road to the headquarters in upper Post Office Canyon, about 7.5 miles from U.S. 80 (passing the Miller Ranch headquarters at about 5.3 miles from the highway).

Accommodations are in Douglas and Portal, Arizona, and in Lordsburg. Researchers may be able to arrange camping with Bioresearch Ranch.

Climate

The area is warm and semi-arid, at least at lower elevations. At Rodeo, 9 miles northwest of and 1,100 to 2,500 feet lower than Central Peloncillo RNA, annual precipitation averages 11 inches (285 mm.). At Chiricahua National Monument, 30 miles west of, but at the same elevation as the canyons of Central Peloncillo, the corresponding figure is almost 18 inches (450 mm.). Climatic data taken at Bioresearch Ranch since 1972 are summarized in figure 15. Precipitation is clearly concentrated in late June–September, and the April–June foresummer is arid. Climate is discussed by Whitfield

and Beutner (1938), Gillerman (1958), and Moir (1977, 1979).

Physiography, Geology, Soils

Gehlbach (1981) describes this Mexican border region. The Peloncillos are a 100-mile-long fault-block range extending north from Mexico along the Arizona-New Mexico border and finally into Arizona, characteristic of the Mexican Highlands section of the Basin and Range Province. To the east lies the Animas Valley, a closed basin (once containing a lake) at about 4,800 feet elevation, and to the west, San Simon Valley at about 4,400 feet elevation. The Peloncillos rise to 6,660 feet, with their highest peaks near Central Peloncillo RNA. Steep slopes give an appearance of greater loftiness (Gillerman 1958). In the RNA the low point, 5,200 feet (1,585 m.), and high point, the Black Mountain summit at 6,500 feet (1,980 m.), are both near the southeast corner.

The RNA includes the north-south axis of the formative anticline and also the divide between Animas Valley and San Simon Valley drainages. Some 70% of the natural area drains east, mostly through Maverick Canyon. Maverick Spring is about a mile above the canyon mouth near the center of the east boundary; it is permanent and is the area's principal source of surface water, maintaining its flow for about half a mile to a dam site. There is also a small but permanent impoundment in the southeast corner of the RNA (Moir 1977).

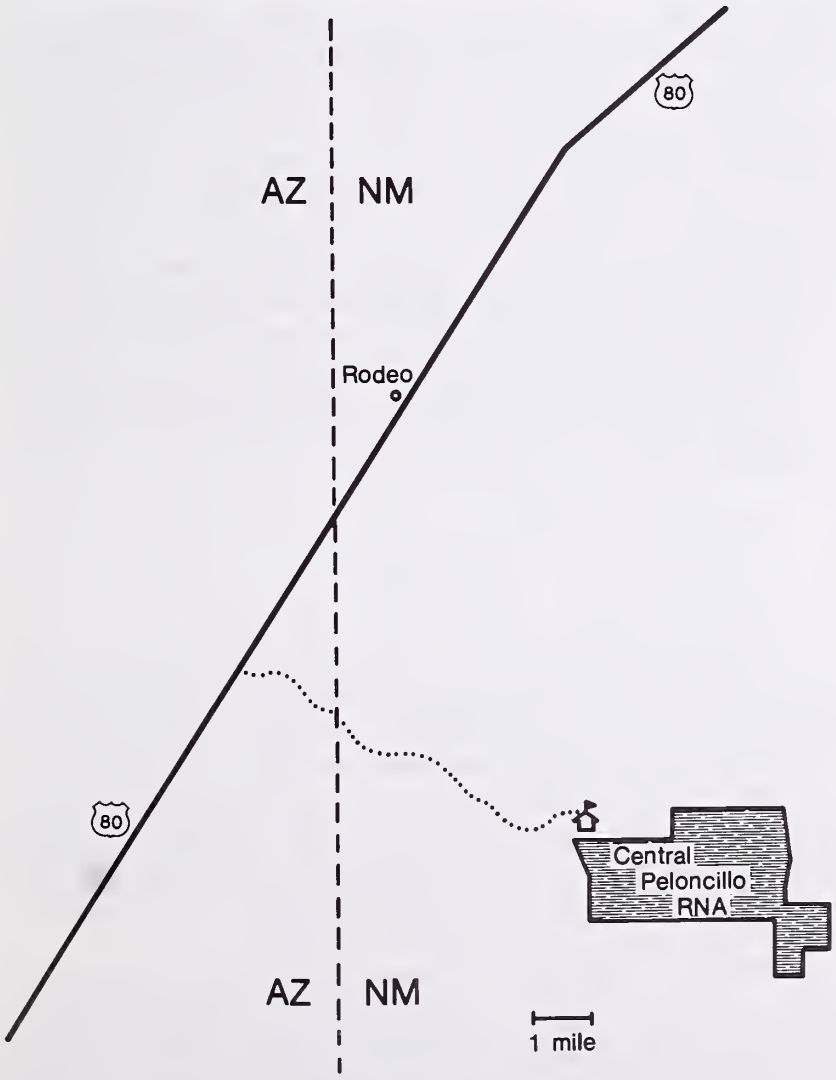

Figure 14. Central Peloncillo RNA.

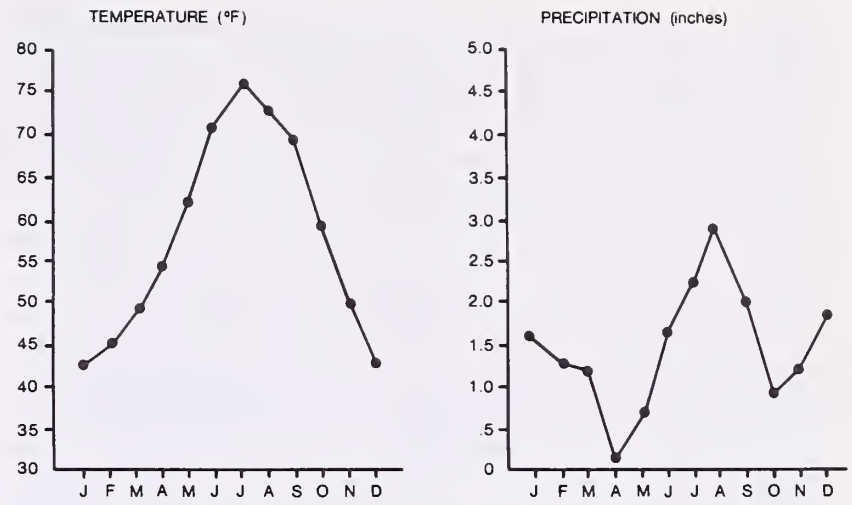

Figure 15. Climate of Central Peloncillo RNA.

The core of the Peloncillos is Precambrian, and Precambrian and Paleozoic strata are exposed north of Rodeo; but in the vicinity of the RNA all exposures are Miocene volcanics. Wrucke and Bromfield (1961) use three map units for what is now the RNA: (1) about 20% of the area is "rhyolite tuffs and welded tuffs," white to light red, containing many annular lapilli; (2) about 75% is "rhyolite welded tuff," pale red-purple to red-brown, with many quartz and sanidine crystals 1 mm. in diameter; and (3) about 5% is rhyolite tuff, poorly compacted, with many angular lapilli, forming the conspicuous cliffs of Skull Canyon. Geology of areas a few miles north is discussed in detail by Gillerman (1958) and by Armstrong et al. (1978), with many data applicable to the RNA. Ross and Smith (1961) and Marjaniemi (1969) discuss the ash-flow origin of most of these tuffs. The Peloncillos were uplifted as a horst block at about the same time as the eruptive volcanic events. No significant mineral deposits are known near the RNA.

Upland surfaces are highly eroded. There are accumulations of alluvium in some canyon bottoms, but others are scoured clean. There are few or no deep soils. Cox (1973) maps the whole area as "rough broken land and rock land," described as acid-igneous, nearly everywhere cobbly and stony, with slopes from 25% to 75%. Moir (1979, 1980) studied soils of the vicinity of the RNA in some detail, and identifies 13 types: Argiustolls, Haplustolls, Haplargids, Ustifluvents, and Usterthents in typic, eroded, aridic, cumulic, or ustollic phases, in addition to the prominent "bare rock" soil.

Vegetation

Moir (1979) discusses vegetation under five general headings: piedmont desert grassland, interior chaparral, Madrean oak woodland, pinyon-juniper woodland, and rock land vegetation. His paper gives species lists, correlations with soil and other site factors, and a map of vegetation that covers the northwest corner of the RNA, around Post Office Canyon. The following paragraphs summarize (and modify slightly) Moir's report.

Piedmont desert grassland is extensive on colluvial and alluvial landforms of low and intermediate elevations. Gramas (*Bouteloua curtipendula*, *B. hirsuta*, *B. gracilis*, and *B. eriopoda*) are most abundant, followed by blue-

stems (*Schizachyrium cirratum* and *Bothriochloa barbinodis*). Few shrubs or trees are present. The soils are Haplustolls, lacking the cobbles that are elsewhere abundant. Better grassland stands are found in the Owl Canyon area of The Nature Conservancy reserve to the north than in the RNA itself.

Interior chaparral, characterized by evergreen sclerophyll shrubs, is made up of two community types. Chaparral savanna, on eroded slopes and uplands, has shrub and grass codominants in open, savanna physiognomy. Toumey oak (*Quercus toumeyi*), manzanita (*Arctostaphylos pungens*), evergreen sumac (*Rhus virens* var. *choriophylla*), mortonia (*Mortonia scabrella*), and sacahuista (*Nolina microcarpa*) are the commonest shrubs, joined by border pinyon (*Pinus discolor*) (fig. 16); all shrubs average a total of 22% cover and perennial grasses 14%. Chaparral woodland, with more pinyon, oak, manzanita, sumac, silktassel (*Garrya wrightii*), and desert buckthorn (*Ceanothus greggii*), averages 47% shrub cover and 3% perennial grasses.

Madrean evergreen woodlands also occur in two community types. Oak savanna is on alluvial fans of the larger canyons; the 15% average tree cover is mainly Emory oak (*Quercus emoryi*), with manzanita and sacahuista runners-up in abundance. Canyon oak woodland, with 43 to 100% tree cover (average 79%), has mainly white-leaf and Arizona white oaks (*Quercus hypoleucoides, Q. arizonica*) with border pinyon, alligator juniper (*Juniperus deppeana*), and squaw bush (*Rhus aromatica*) also common. But some of Moir's woodland species are not confirmed by Todsen (1980) for the RNA itself, and may be from the more southerly part of Moir's study area.

Pinyon-juniper woodland is found between 5,600 and 6,400 feet elevation, usually on steep slopes (fig. 17). Border pinyon usually dominates, with alligator and one-seed junipers (the latter *Juniperus monosperma* in the widest sense of that species) and Arizona white oak. Pinyon-juniper savanna, with 4–30% tree cover, may be distinguished from pinyon-juniper woodland in the strict sense, with 35–85%. The woodier community is on deeper soils than the savanna, which is commonly on bare rock soil.

Figure 16. Desert shrub-steppe. Central Peloncillo RNA. (File photo, BLM, Las Cruces.)

Figure 17. Pinyon-juniper woodland. Central Peloncillo RNA. (File photo, BLM, Las Cruces.)

Rock land—80% or more rhyolite bedrock—has lichens, small cacti, annuals, and infrequent perennial grasses and crevice plants, with an occasional low pinyon. This vegetation type is colorful and abundant.

Studying flora rather than vegetation, Todsen (1980) found many interesting species in the RNA, including *Brickellia simplex, Plummera ambigens, Echinocereus pectinatus* var. *rigidissimus, Ferocactus wislizeni, Mammillaria macdougalii,* and *Cheilanthes pringlei.* He lists about 250 taxa of vascular plants other than grasses for the area. Species and vegetation types are frequently near their northern or eastern limits here, and Todsen found several plants new to New Mexico in the RNA.

Küchler (1975) maps the higher Peloncillos as oak-juniper woodland (Type 31) and lower elevations of the area as grama-tobosa shrubsteppe (Type 58). Donart et al. (1978) map the area as the brush-juniper series of mountain shrub (Type MS–2). While not wrong, these broad categories fail to reflect the intricate mosaic of vegetation and its largely Madrean relationships.

Vegetation of the area is recovering from a long period of serious overuse by goats and cattle. Only a few inaccessible ledges escaped abuse. High erodibility slows revegetation.

Animals

For an area presumed to be low in productivity due to denudation, Central Peloncillo RNA displays a diversity and abundance of wildlife. This diversity received attention when natural-area efforts in New Mexico were young: in a 1967 meeting this Black Mountain area was described as uniquely providing habitat for four desert species—coati, Coues' white-tailed deer, a heavy population of javelina, and band-tailed pigeons, and possibly also whiskered owls (USDI BLM 1967).

Mammals characteristic of the desert mountains identified within the RNA include Coues' white-tailed deer, javelina, coati, ringtail, hog-nosed skunk, hooded skunk, and desert shrew. Other, wider-ranging species in the RNA include mule deer, coyote, gray fox, mountain lion,

bobcat, black bear, striped skunk, cottontail, blacktail jackrabbit, rock squirrel, cliff chipmunk, whitethroated woodrat, yellow-nosed cotton rat, brush mouse, rock pocket mouse, pocket gopher, and bats.

Reptiles and amphibians have been studied by Jones (1976), Bogert (1977), and Dixon (1978). Lizards reported in the RNA include *Cnemidophorus sonorae*, *Crotaphytus collaris*, *Gerrhonotus kingi*, *Holbrookia maculata*, *Phrynosma cornutum*, *P. douglassi*, *Sceloporus clarki*, *S. jarrovi*, *S. magister*, *S. poinsetti*, *S. undulatus*, *S. virgatus*, *Urosaurus ornatus*, and *Uta stansburiana*, and a record of the Gila monster (*Heloderma suspectum*) in or near the RNA. Snakes reported include *Crotalus atrox*, *C. lepidus*, *C. molossus*, *Elaphe triaspis*, *Hypsiglena torquata*, *Masticophis bilineatus*, *Pituophis melanoleucus*, *Salvadora grahamiae*, and *Thamnophis cryptopsis*. Mud turtle (*Kinosternon* sp.) and desert tortoise (*Gopherus agassizi*) are recorded by Dr. Scholes. *Bufo alvarius*, *B. punctatus*, and *Hyla arenicola* are the identified amphibians. Studies of birds have been intensive, with about 150 species recorded in the RNA including 6 ducks, 14 raptors, 5 doves, 4 goatsuckers, 7 hummingbirds (including Lucifer), 8 woodpeckers, 5 corvids, 6 parids, 6 wrens, 5 mimids, 11 warblers, 7 icterids, and 25 fringillids. Counts since Christmas 1973 have been published, and a permanent transect for detailed observation has been maintained since 1981.

Archaeology

Site numbers have been assigned by the Laboratory of Anthropology (Museum of New Mexico, Santa Fe) to four sites recorded by A. Hayes in a 1980 survey.

Intrusions and Threats

The area was grazed by cattle from about 1880–1900, then also by goats for two or three decades. Cattle grazing continued legally until 1973, when 56 cattle year-long were allowed on the federal 2,511 acres (448 "forage acres")—a very high level of demand on this desert grassland. Effects of grazing will remain for decades or centuries, since soil was lost from denuded slopes.

Two-track roads crossed the mountains, connecting Maverick Canyon on the east with Skull and Post Office canyons on the west and with a canyon that drains south past Mt. Baldy. On steep slopes these roads are deeply eroded and unusable, even were vehicles permitted.

The 1918 topographic map shows two buildings in Maverick Canyon, and there have been others on the area from time to time. Several small dams and stock ponds have been built, of which two are maintained. The depredations of non-native feral swine, often visible in woodland, may be regarded as a continuing intrusion.

Research

Bioresearch Ranch has sponsored a research program in the RNA probably unmatched in southwestern New Mexico, including birdbanding, insect collections, and, prominently, the work of W. H. Moir (1979, 1980, and other reports) on vegetation, soils, and hill-slope processes. The Bureau of Land Management, New Mexico Department of Game and Fish, and the New Mexico Heritage Program have sponsored censuses in the RNA, such as Dixon's (1980), Todsen's (1980), and a 1977 deer census.

Maps

Topographic: USDI—Geological Survey 1:62,500 series, Animas Peak Quadrangle, 1918. Resurveyed around 1977 but not yet published. Vegetation: part of the RNA is included in Moir (1979). Soils: Cox (1973) uses a single mapping unit for the RNA. For aerial photography see Cox (1973).

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CHUPADERA RESEARCH NATURAL AREA

Desert shrubsteppe dominates this mountainous, 5,389-acre wilderness and natural area. The highest, rocky hills rise 1,420 feet above the low edge of the area along Interstate 25. Most of the area is covered by gravelly terraces and bajadas that now support only creosotebush and a thin grass cover. Higher slopes and valleys support a variety of shrubs and grasses. Wildlife is limited by lack of permanent water, but includes several desert-adapted species.

Administration

Refuge Manager
Bosque del Apache National Wildlife Refuge
P.O. Box 1246
Socorro, NM 87801 (505) 835–1828

Chupadera is one of five natural areas on the Bosque del Apache Refuge, a 57,191-acre unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1939 on land purchased by the federal government in 1936. Chupadera was designated as a 5,289-acre (2,140-hectare) Research Natural Area December 7, 1972. (A previous proposal would have established a 320-acre natural area centered a mile east of Chupadera Peak. This is within the larger area actually designated.) In 1975 the Congress declared the same area a wilderness.

Entrance and exit by Refuge roads is allowed only during daylight. Hunting of deer, dove, quail, and rabbits is allowed in season. Mineral entry (including prospecting) is prohibited, as are vehicles and livestock. The whole area is fenced except for a few west-side crags regarded as impassable to livestock.

Location and Access

Chupadera Research Natural Area is in Socorro County at lat. 33°50′N., long. 106°56′30″ W. (fig. 18). Part of a land grant, the area was not surveyed by the United States but would be in T. 5 S., R.1 W., and T. 6 S., R. 1 W. The eastern boundary is the Interstate 25 right-of-way, and other boundaries are the north, west, and south boundaries of Bosque del Apache Refuge.

Chupadera is 90 miles south of Albuquerque (14 south of Socorro) and 126 miles north of Las Cruces (or 54 north of Truth or Consequences). For ingress to the

natural area from Refuge roads (open only during daylight hours), turn off I–25 onto N.M. 1 at San Antonio from the north or San Marcial from the south and follow Refuge signs. A convenient route is by a road that heads northwest from N.M. 1, 2 miles north of Refuge headquarters. Passage on foot under the interstate highway is through a large culvert.

Accommodations are available in Socorro.

Climate

Climate of creosotebush areas south of Socorro, such as Chupadera, is discussed by Gardner (1951), and climate of the county is discussed by Houghton (in Maker et al. 1972). Data from Refuge headquarters, 2.6 miles east of and 300 feet lower than the lowest part of Chupadera, are given above under Apache Camp RNA.

Physiography, Geology, Soils

The area is in the Mexican Highlands section of the Basin and Range Province (Fenneman 1931). The Chupadera Mountains, on whose eastern slopes and foothills the RNA is located, are a northeast-southwest trending range of which Chupadera Peak, at the west edge of the RNA, is the highest, 6,273-foot (1,912 m.) peak, 1,420 feet above the eastern boundary at 4,853 feet (1,479 m.). This southern section of the Chupadera Mountains is also known as Coyote Hills. They appear craggy; 50- to 100-foot cliffs are common. This is a typical fault-block range, part of the Lemitar-Socorro-Chupadera chain formed by deformation in late Tertiary or in Quaternary time (Denny 1940). Deformation continues; the Chupaderas are at the southern end of a 45-mile line in which the rate of uplift (north of Socorro) is 5 mm. per year (Reilinger and Oliver 1976).

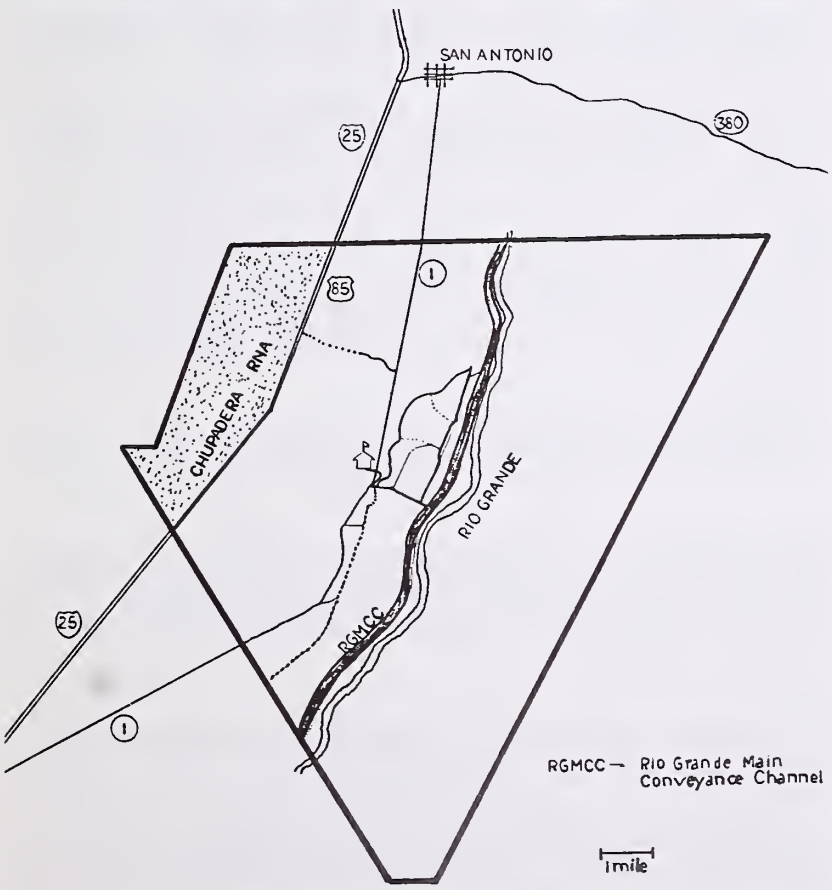

Figure 18. Chupadera RNA.

The core of the range is of igneous and metamorphic Precambrian rock, exposed at the west edge of the natural area where coarsely crystalline granite and gneiss intrude gray muscovite-hornblende schist (Bachman and Stotelmeyer 1967, Eggleston 1982, Kent 1982). Overlying are about 30 feet of Mississippian Calosa Formation and 200 feet of Pennsylvanian Madera Formation—mostly a cliff-forming limestone—each with small areas of outcrop (Kottlowski 1960). Armstrong (1959) reports crinoids, brachiopods, and mollusks in the Calosa Formation here, and Kottlowski (1960) records brachiopods, fusulinids, and horn corals from the Pennsylvanian. Most of the mountain area within the RNA is covered by Tertiary volcanics of the Datil formation, described by Dane and Bachman (1965) as welded and crystal tuffs, flows, and breccias.

Below the steep mountain slopes are 4–8% easterly slopes cut by steep-sided washes; these bajadas cover most of the natural area. In the central part some poorly consolidated strata of the Tertiary Santa Fe Group are exposed, dipping 65° west (Bachman and Stotelmeyer 1967). Quaternary terrace gravels top the Tertiary formation over most of the bajadas. Ruhe (1967) discusses the pediments that shape these landforms along the Rio Grande.

Soils in the area are thermic-aridic, of rocky or gravelly texture. On the bajadas are several members of the Nickel-Canutio-Rough Broken Land association, typically with a gravelly caliche layer a foot or two deep (Maker et al. 1972)—or sometimes, it appears, much closer to the surface. This association belongs to Torrifluvents-Calciorthids-Torriorthents great groups. On the mountains are soils of the Rock Land-Lehmans-Lozier association, largely (in our area) Rock Land, a miscellany of shallow soils and rock outcrops. This association is classified as Rockland-Haplargids.

Vegetation

The bajadas are sparsely covered by creosotebush (*Larrea tridentata*), with bush muhly (*Muhlenbergia porteri*) under many of the shrubs (fig. 19). Other necessarily-tough survivors on these gravelly slopes are black grama (*Bouteloua eriopoda*), three-awns (*Aristida glauca* and *A. longiseta*), fluffgrass (*Erioneuron pulchellum*), burro grass (*Scleropogon brevifolius*), tobosa (*Hilaria mutica*), and snakeweed (*Gutierrezia sarothrae*). But much of the gravel surface is bare.

On the mountains the vegetation is desert shrubsteppe, of greatly varying density depending on the character of the erosion surfaces. Shrubs include one-seed juniper (*Juniperus monosperma*), sotol (*Dasylirion*), sacahuista (*Nolina*), yuccas (*Yucca baccata* and *Y. glauca*), four-wing saltbush (*Atriplex canescens*), sumacs (*Rhus microphylla* and *R. aromatica* var. *trilobata*), feather plume (*Dalea formosa*), snakeweed, and low sage (*Artemisia arbuscula*). Grasses include galleta (*Hilaria jamesii*), gramas (*Bouteloua curtipendula* and *B. gracilis*), dropseeds

(*Sporobolus* spp.), slim tridens (*Tridens muticus*), hairy tridens (*Erioneuron pilosum*), and bluestems (especially *Bothriochloa barbinodis*) (fig. 20). Creosotebush goes high on the hills, at least to 5,400 feet elevation, where it sometimes grows in quite dense grass stands (fig. 19); but in such situations many creosotebushes are dying.

Ecology of creosotebush stands on the Rio Grande bajadas is discussed by Gardner (1951), Yang (1961), Dick-Peddie (1975), Welsh and Beck (1976), and Stein and Ludwig (1979).

Küchler (1975) maps the potential natural vegetation as creosotebush-tarbush (Type 44), but most members of that association are lacking. One hopes that this is potentially his Type 58, grama-tobosa shrubsteppe.

Animals

Mule deer, coyote, black-tailed jackrabbit, and burrowing rodents such as kangaroo rats and ground squirrels are in evidence. Mountain lion, desert cottontail, woodrat, pocket gopher, and several mouse species are likely. Occasional pronghorns are recorded here (USDI—Fish and Wildlife Serv. 1970).

Several lizard and snake and many bird species are common; among the birds are Gambel's quail and mourning dove. There are nest sites for hawks and owls.

Figure 19. Creosotebush and grass. Chupadera RNA.

Figure 20. Slopes of the Chupadera Mountains.

Intrusions and Threats

The principal intrusions are noise and lights from traffic on Interstate 25, which runs the length of this narrow RNA. An abandoned bladed road from the east leads up to a shallow rock quarry at the south foot of "Cone RG." The quarry has mostly grown over, but much of the road, though unused for at least 8 years, is bare and conspicuous. There are a 7-foot pit and a 6-foot shaft in the Madera limestone outcrop; apparently these explored a thin coating of manganese mineral.

Research

Only geologic research is known; see Eggleston (1982) and Kent (1982).

Maps

Topographic: USDI—Geological Survey 1:24,000 series, Indian Well Wilderness Quadrangle, 1981. Geology: Bachman and Stotelmeyer (1967), Eggleston (1982), Kent (1982), Kottlowski (1960). Soils: Maker et al. (1972).

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GALLINAS RESEARCH NATURAL AREA

A 345-foot-deep river canyon cuts the rolling grassland and conifer woodland of this 385-acre wildlife (and livestock) area. The Dakota Sandstone is well exposed along canyon rims in this fine exemplar of the Las Vegas Plateau. A rich array of grasses grows in and near the canyons.

Administration

Refuge Manager
Las Vegas National Wildlife Refuge
P.O. Box 1070
Las Vegas, NM 87701 (505) 425–3581

The 9,450-acre Refuge is a unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established on purchased land in 1966 to restore wildlife habitat. The 385-acre (156-hectare) RNA was designated August 17, 1973.

The Research Natural Area is not posted or fenced as such. A permit is required to visit the area, as it is for other "backcountry" parts of the Refuge. Hunting is prohibited.

Cattle are grazed in the RNA under permit to local ranchers. The east section was grazed for 5 weeks in September–October 1981, but rested in 1980 and 1982. The west section has not been grazed in 1980–1982.

Although 0.2 miles of the bottom of Gallinas Canyon are included in the Refuge and in the RNA, they are not fenced or posted and are not managed by the Refuge Manager. Maps given to the public (as in USDI—Fish Wildlife Serv. 1980) exclude the canyon bottom from the Refuge. That area is "overgrazed annually by livestock" according to the Refuge Manager in 1982.

Gallinas and Vegosa RNA's could well be considered as one, though separated by 0.5 miles.

Location and Access

Gallinas Research Natural Area is in San Miguel County, centered at lat. 35°30′20″ N., long. 105°11′00″ W. (fig. 21). The area was not included in the general land survey, but would be mostly in T. 15 N., R. 16 E., with the east edge in T. 15 N., R. 17 E. The north boundary of the RNA appears to lie along lat. 35°30′41″ N., the east along long. 105°10′36″ W., the west along long. 105°11′41″ W., and the south, which has 3 segments, is the south Refuge boundary between those longitudes.

Las Vegas National Wildlife Refuge is 5 miles southeast of Las Vegas. From downtown Las Vegas or from the N.M. 65–104 interchange of Interstate 25, drive east on N.M. 65–104 about 1.5 miles, turn south on N.M. 281 and follow its turns (east and then south again) for 4.5 miles to Refuge headquarters. There a permit to enter the RNA may be sought. Gallinas RNA is in the south end of the Refuge. From headquarters the main road goes south 2.4 miles, then west and northwest 1.2 miles; there turn south on a branch road for 0.7 miles, almost to the RNA.

The nearest accommodations are in Las Vegas. Camping is permitted at McAllister Lake, 0.6 miles northeast of the RNA, in an area managed by the New Mexico Department of Game and Fish.

Climate

Las Vegas and the Refuge are in a cool, moist area with mean temperature 50°F (10°C) and average annual precipitation of 16 inches (400 mm.). The record low is –31°F (–35°C), the high 100°F (38°C). The growing season is about 160 days. Climate of the area is discussed by Griggs and Hendrickson (1951) and by Hilley et al. (1981). Monthly averages from Las Vegas (Station 4,850), 7 miles northwest of the RNA are shown in figure 22.

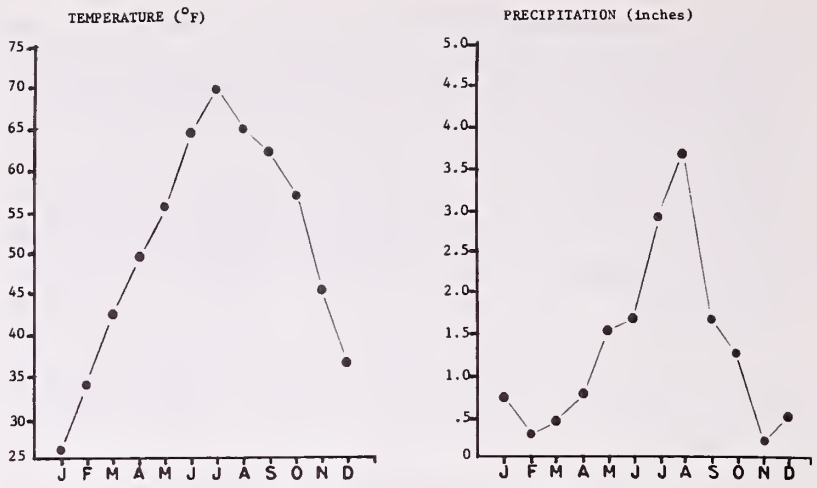

Figure 22. Climate of Gallinas RNA.

Physiography, Geology, Soils

Gallinas Research Natural Area is near the western limit of the Great Plains; the Sangre de Cristo Mountains are 4 miles to the west. And it is at the southwestern limit of the Las Vegas Plateau, which includes much of New Mexico east of the Sangre de Cristos (Fenneman 1931). Like the Plateau in general, the RNA is a peneplain on Dakota Sandstone deeply cut by stream action. Unlike nearly all the Plateau, the Las Vegas Refuge drains to the Pecos River (and thence to the Rio Grande) rather than the Canadian (thence to the Arkansas and the Mississippi). Lee (1903) discusses canyons of the Las Vegas Plateau.

The Gallinas River flows through the southwest edge of the natural area in a 345-foot-deep canyon. The area is further cut by a side canyon of the Gallinas that begins at the north edge of the natural area and empties southward, reaching a depth of 310 feet in its half-mile crossing of the area. With the aid of a little fencing near its origin this canyon effectively divides the area into two sections.

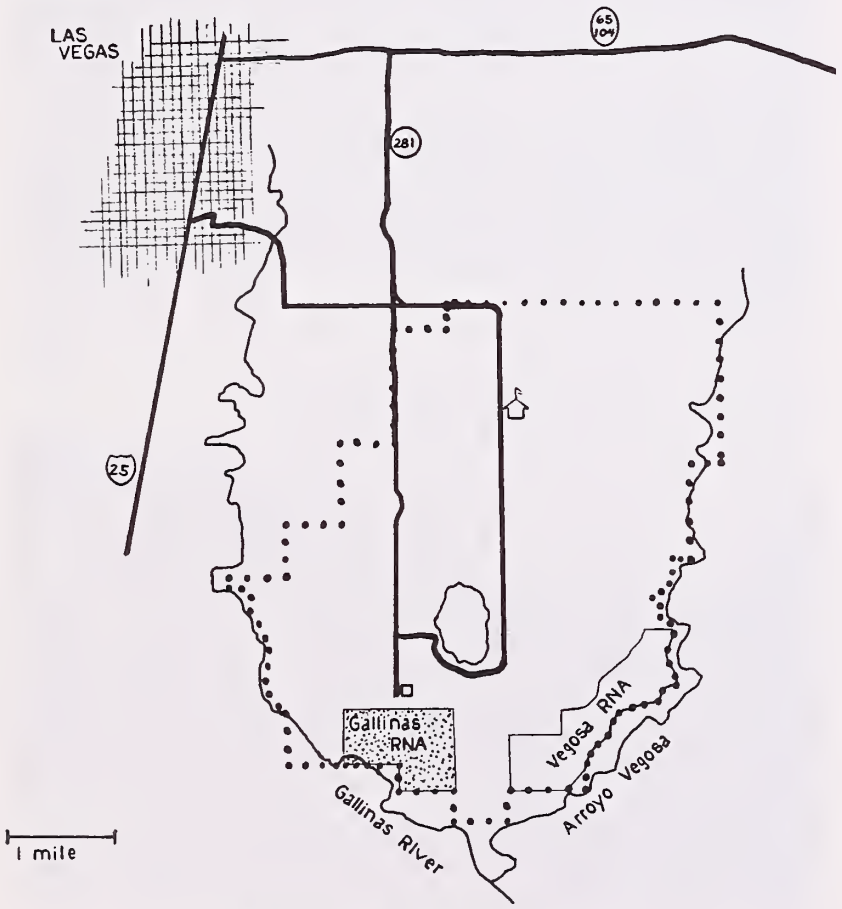

Figure 21. Gallinas RNA.

Eastern and northwestern parts of the RNA, comprising about 320 acres, are uplands with slopes less than 6%, mostly less than 3%. About 65 acres are in the canyons: 60 acres with slopes averaging more than 60% and 5 acres of flat canyon bottom. Edges of the canyons are abrupt; the top 15 feet or so are generally vertical. Elevations in the RNA range from 6,058 to 6,475 feet (1,847 to 1,974 m.).

The caprock, which may be more than 200 feet thick here, is Dakota Sandstone, of Late Cretaceous age. It is abundantly exposed along the 1.45 miles of canyon edge in the RNA. Griggs and Hendrickson (1951) describe the formation as fine-grained, highly quartzitic sandstone, containing pebbles of quartz and of chalcedonic silica. Several small towers on the lip of Gallinas Canyon show relatively fresh, white to buff surfaces of the sandstone. Older surfaces are dark red or brown. Exposed in canyons below the Dakota is, presumably, the Morrison Formation (Jurassic), here taken to include the Upper Cretaceous Purgatoire Formation, if present; it includes various sandstones and shales.

Further geological information is given by Bejnar and Lessard (1976), Jacka and Brand (1972), and Lessard and Bejnar (1976).

Soils are mollisols of the great groups Argiustolls and Paleustolls, produced by a mesic soil regime in a ustic moisture regime (Hilley et al. 1981). Five mapping units are in the RNA but three of them, on flat to rolling uplands, are mainly Partri loam, typically with the surface layer about 4 inches of dark silt loam. On the east side of the RNA Tricon loam, a Petrocalcic Paleustoll, is mixed with Partri loam, and there are also small areas of Bernal and perhaps of Carnero soils. Nearer canyon edges, covering almost half the RNA, is Bernal loam, with a brown surface layer about 6 inches thick and the parental sandstone less than 2 feet down. Canyons are mapped as "steep Tuloso-Rock Outcrop-Sombordoro Association," comprising stony sandy loam and rock.

Vegetation

Uplands farthest from canyon edges are grasslands; closer to the canyons, including an area of 60 or 70 acres east of the side canyon, is pinyon-juniper woodland

grading into juniper-oak savanna (fig. 23). Along the edges are ponderosa pines with Rocky Mountain juniper. Canyon sides are mainly covered with shrubs such as Apache plume (*Fallugia paradoxa*), but also grasses and scattered conifers (fig. 24). Grasses and sedges dominate the narrow canyon bottoms.

Grasses on wetter sites, including upper reaches of the side canyon and near conifers, are a rich mix of mid- and tall-grasses: Indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), silver bluestem (*Bothriochloa saccharoides*), sideoats grama (*Bouteloua curtipendula*), and, here at their northern known limits, plains lovegrass (*Eragrostis intermedia*) and bullgrass (*Muhlenbergia emersleyi*).

Hilltop sites and northern parts of the RNA are more heavily grazed and have a less impressive variety of plants, mainly gramas (*Bouteloua gracilis* and *B. curtipendula*), wolftail (*Lycurus phleoides*), sand dropseed (*Sporobolus cryptandrus*), windmillgrass (*Chloris verticillata*), ring muhly (*Muhlenbergia torreyi*), fringed sage (*Artemisia frigida*), and soapweed (*Yucca glauca*). Grassland is apparently being invaded by juniper (*Juniperus monosperma* and *J. scopulorum*) and oak (*Quercus undulata*).

Least muhly (*Muhlenbergia minutissima*) is frequent in crevices on level rock surfaces, and spleenwort (*Asplenium septentrionale*) is common in crevices on cliff faces.

Although vegetation is listed as potentially grama-buffalo grass (Küchler's Type 65) in the Directory of Research Natural Areas (U.S.—National Science Foundation 1977), that seems unlikely except possibly for a small area in the northeast of the RNA. Küchler (1975) himself maps Juniper-Pinyon Woodland (Type 23) and Grama-Galleta Steppe (Type 73). Hilley et al. (1981) suggest mainly blue and sideoats grama, galleta, and western wheatgrass for the Partri and Tricon soils; and although there is not much galleta or wheatgrass in evidence now, this seems a likely prognosis if livestock grazing continues light.

Animals

Mule deer, Nuttall's cottontail, black-tailed jackrabbit, coyote, and bobcat are the common larger mammals.

Figure 23. Juniper savanna. Gallinas RNA.

Figure 24. Canyon of the Gallinas River within Gallinas RNA.

Also likely are desert shrew, gray fox, raccoon, long-tailed weasel, mink, striped skunk, mountain lion, and many rodent species.

Red-tailed hawk, golden eagle, prairie falcon, kestrel, scaled quail, ring-necked pheasant, turkey, long-billed curlew, mourning dove, nighthawk, white-throated swift, black-chinned and broad-tailed hummingbirds, red-shafted flicker, Lewis' woodpecker, and 37 species of passerine birds are listed as "common" on the Refuge and might well be in Gallinas RNA (USDI—Fish Wildlife Serv. 1984).

Intrusions and Threats

A home (the state game warden's) is 200 feet north of the RNA; a small water impoundment there reaches the edge of the natural area. An even smaller, usually dry impoundment is mapped near the eastern edge of the RNA. The uplands are grazed by cattle but apparently only lightly; damage to vegetation is probably mainly from pre-Refuge days.

The principal intrusion is that a fine stretch of the Gallinas River within the Research Natural Area has been left "outside" for all practical purposes, and is used for a private ranching operation.

Research

None is known.

Maps

Topographic: U.S. Geological Survey 1:24,000 series, Las Vegas Quadrangle, 1963. Geology: Griggs and Hendrickson (1951). Soils: Hilley et al. (1981). Aerial photography: see Hilley et al. (1981).

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GILA RIVER RESEARCH NATURAL AREA

The Gila River here winds through the Big Burro Mountains in a 600-foot-deep canyon, its sloping walls interrupted by side canyons. The natural area was established mainly to protect habitat for hawks, falcons, herons, and songbirds here at the edges of their distributions. It may be more important for protection of native fish species. Riparian woodland is now represented in the area by a sparse line of cottonwoods, sycamores, ashes, and hackberries, floods having destroyed many trees in recent years. Most of the 402 acres are desert shrubland.

Administration

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The co-administrators represent national forest and research branches of the Forest Service, U.S. Department of Agriculture. On-the-ground management is by the District Ranger, Silver City District, Gila National Forest, also in Silver City.

These lands in the Big Burro Mountains were added (from public domain lands) to the Gila National Forest in 1907 and 1909. After several years of proposals Gila River Research Natural Area was designated June 23, 1972, mainly to protect riparian habitat for rare or endangered bird species. Its area is 402 acres (163 hectares). It is intended as a natural control area for the Gila River Bird Habitat Management Unit immediately upstream; there (but not in the RNA) manipulation of vegetation to improve habitat was planned (USDA—Forest Serv., 1972). It was recognized that the Research Natural Area was sub-optimal for riparian habitat, but the area was chosen because it was relatively pristine and in deference to possible mining claims near better cottonwood stands upstream (USDA—Forest Serv. 1969).

The RNA is open to hunting and grazing. It is closed to off-road vehicles, and the road-end is blocked at the head of the canyon, 2.5 miles upstream from the RNA, but this closure has continued to be violated at least occasionally and presents an enforcement problem. The natural area is not fenced or posted. Withdrawal from mineral entry was proposed in the Federal Register in 1970 but was not made final until September 2, 1975, due to controversy; but the difficulty mainly concerned upstream areas also proposed for withdrawal rather than the RNA itself. The Forest Service has tried to defend water rights to protect in-stream flow in this part of the Gila River (USDA—Forest Serv. 1972).

Location and Access

Gila River Research Natural Area in Grant County, centered at lat. 32°47′00″ N., long. 108°36′45″ W. (fig. 25). It is in T. 17 S., R. 17 W., in sec. 32 (E1/2 of the E1/2) and sec. 33 (NW1/4, and W1/2 of the SW1/4).

The RNA is 12 miles south of Cliff and 30 road miles west of Silver City. From Socorro the route via Interstate 25, N.M. 90, and U.S. 180 is 199 miles, or about 15 miles shorter than that via U.S. 60, N.M. 12, and U.S. 180. From Las Cruces the distance by Interstate 10 and U.S. 180 is 149 miles. Turn south from U.S. 180 on Forest Road 809, 1.2 miles west of the N.M. 211 junction (= 4 miles southeast of Cliff). Drive south on 809 to its end. Thence walk, float, or paddle downstream for about 2.5 miles to the RNA. Wading the river saves rockclamber-

ing at two or three points. Rough National Forest roads suitable for high-clearance vehicles approach within 1.5 miles of the RNA from both east (Wild Horse Mesa) and west (Telegraph Mountain).

Accommodations are in Silver City, 30 miles east, and in Pleasanton and Glenwood, 30 and 34 miles northwest. There is a campground at Bill Evans Lake (see figure 25), and camping is allowed on these National Forest lands.

Climate

This is a semi-arid area, with average annual precipitation about 12 inches (300 mm.) and mean temperature 59°F (15°C). Half the annual precipitation falls from July to September in brief but intense thundershowers; a storm that brings 1.6 inches of rain within a single 24-hour period is expected (on average) once in 2 years. Climate of the area is discussed by Henry (1981), Maker et al. (1971), and in some detail by Trauger (1972). Monthly averages from data at Red Rock (Station 7340), 10 miles downstream and 100 feet lower than Gila River RNA, are graphed in figure 26.

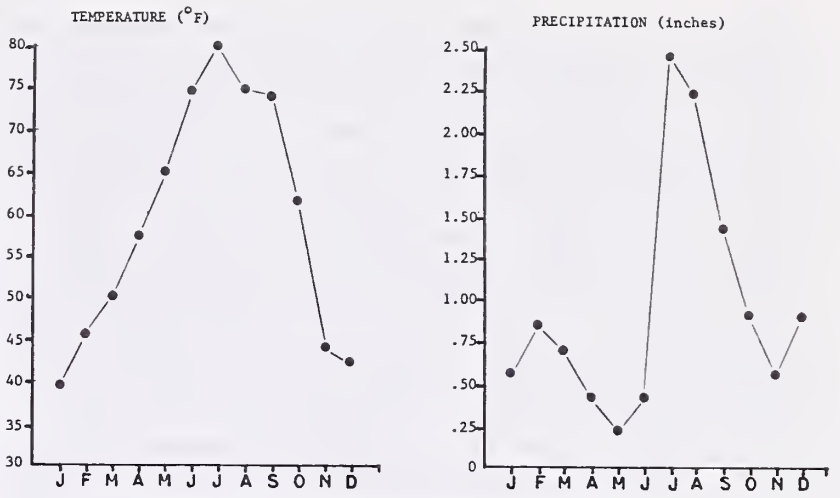

Figure 26. Climate of Gila River RNA.

Physiography, Geology, Soils

The Big Burro Mountains, here deeply cut by the Gila River, are a southwestward extension of the Gila highlands (at the edge of the Colorado Plateau) into the Basin and Range Province (Fenneman 1931). Burro Peak, on the Continental Divide, is highest in the range at 8,035 feet elevation. The Gila drains those highlands and flows south and then across Arizona to the Colorado River near Yuma. Use of river water for irrigation is heavy and most of this long channel is dry most of the time, but flow is perennial through the Middle Gila Box in which the RNA is located.

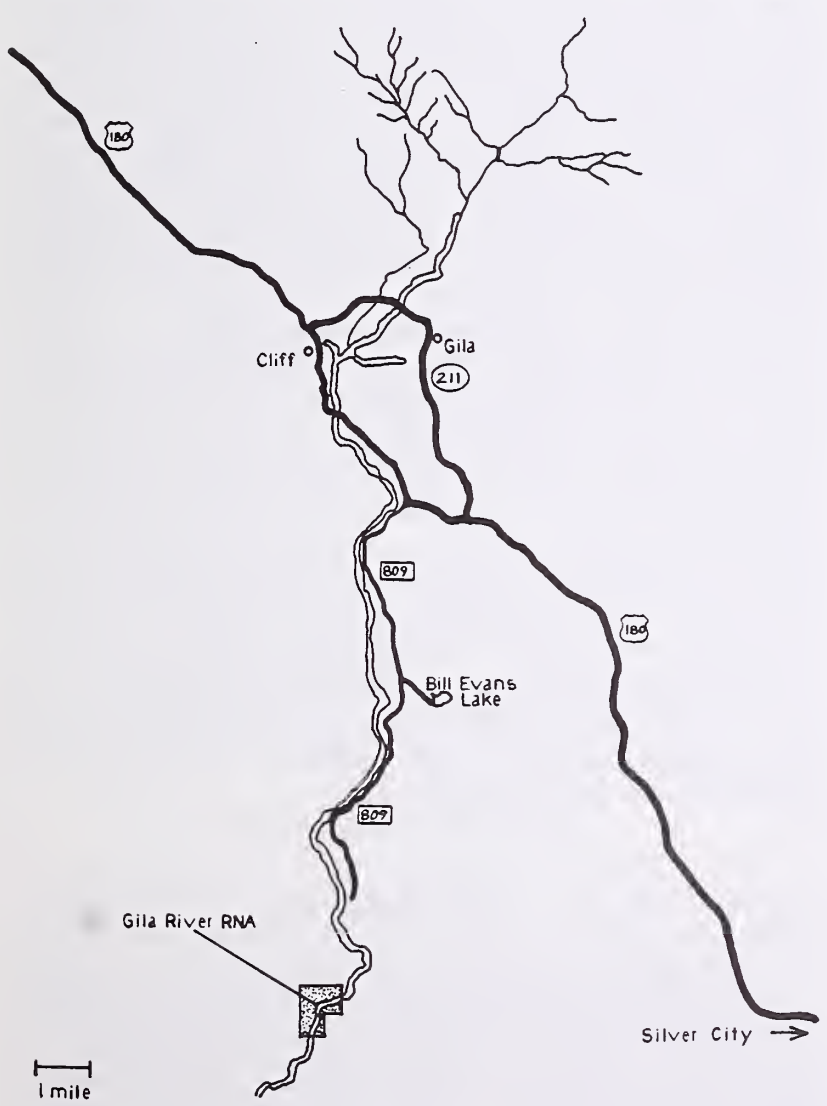

Figure 25. Gila River RNA.

This canyon, scarcely a box, has slopes characteristic of the Big Burros: 20–50%, with only occasional steeper pitches and small cliffs. High points of the RNA (in both north and south ends) are at 4,880 feet (1,487 m.) elevation; the low point, where the river leaves after dropping 35 feet in the RNA, is at 4,250 feet (1,295 m).

Average flow of the Gila above Red Rock, 6 miles below the natural area, is 194 cubic feet per second (*cfs*), reaching a high of 402 cfs in March and a low of 66 cfs in June (Trauger 1972). The least flow recorded near Red Rock from 1905 through 1981 was 2.2 cfs and the greatest, in 1978, was 48,800 cfs (USDI-Geol. Surv. 1982). These readings are probably close to those that would be measured at the RNA itself.

Five ephemeral streams enter the Gila in its approximately 1.5-mile course through the RNA. We list them because of confused name-reversals on some maps: from the right (or west) side, proceeding downstream, (1) Faucet Canyon, (2) an unnamed stream in the center of the RNA, and (3) Pyrite Canyon near the southern border of the RNA; from the left (east or south) side, (1) an unnamed canyon at the northeast boundary of the RNA that drains Ira Ridge and, near it (2) Wild Horse Canyon. A stream from St. Peter's Rock enters just above the RNA and Buzzard Canyon enters 500 feet below it.

The Big Burro Mountains consist mainly of Precambrian granite and associated rocks—such as a quartz diorite gneiss—of the Burro Mountain batholith (Gillerman 1964). These Precambrian strata are mapped for the southern 270 acres of the RNA by Trauger (1972) but only for a southeastern 60 acres by Gillerman (1964). Both authors show Cretaceous strata in the southwest part of the RNA; for Trauger it is the Beartooth Quartzite (with the Colorado Formation 0.5 miles farther west); for Gillerman it is shale and sandstones of the Colorado Formation (with Beartooth Quartzite 0.2 miles farther west). USDA—Forest Service (1969) lists both formations. Both

authors map the northern part of the natural area as Datil Formation, a complex of Tertiary rhyolite, flow breccia, tuff, ash, and ashflow welded tuffs formed during a cycle of eruptions in Oligocene time. According to Trauger the Datil-Precambrian border is the east-west Wild Horse Fault, along which the river flows west for half a mile. Hewitt (1959) has also done detailed geological mapping of this area, which is the Red Rock Mining District.

Soils of the Research Natural Area are aridic-lithic Haplustolls and Argiustolls of the Rockland-Luzena-Santana Association (Maker et al. 1971), mostly stony or cobbly loams. In the narrow floodplain and on alluvial fans just above it are fine-loamy San Mateo and Shanta soils, which are ustic Torrifluvents and cumulic Haplustolls.

Vegetation

Desert shrubs cover about 340 of the RNA's 400 acres, although a very thin scattering of one-seed junipers (*Juniperus monosperma* in the wide sense) and pinyon (*Pinus edulis* var. *fallax* and var. *edulis*), mostly on north slopes, led to classification of 125 of the 340 acres as pinyon-juniper woodland (USDA—Forest Serv. 1969) (fig. 27). Ten acres or so are really dominated by conifer woodland.

Prominent on slopes of the desert shrub steppe are soapweeds (*Yucca* spp.), sotol (*Dasylirion wheeleri*), shrub live oak (*Quercus turbinella*), mesquite (*Prosopis*), whitethorn (*Acacia constricta*), wait-a-bit (*Mimosa biuncifera*), ocotillo (*Fouquieria splendens*), prickly pear (*Opuntia engelmannii* and others), desert buckthorn (*Ceanothus greggii*), oreganillo (*Aloysia wrightii*), wolfberry (*Lycium pallidum*), turpentine bush (*Ericameria laricifolia*), and snakeweed (*Gutierrezia sarothrae*). The many grass species include gramas (*Bouteloua* spp.), sprangletop (*Leptochloa dubia*), tridens (*Tridens muticus*), and threeawns (*Aristida orcuttiana* and others). In dry washes are added to this list alligator juniper (*Juniperus deppeana*), burrobrush (*Hymenoclea monogyra*), rock sage (*Salvia pinguifolia*), hedge nettle (*Stachys coccinea*), *Baccharis* species, and large grasses including bullgrass (*Muhlenbergia emersleyi*), deergrass (*M. rigens*), and bristlegrass

Figure 27. The southern half of Gila River RNA. Old road in lower right.

Figure 28. Sparse riparian woodland of Gila River RNA.

(*Setaria macrostachya*). The only large alluvial fan of the natural area, formed by wash from Faucet Canyon and the stream next south, supports a dense mesquite grove with patches of burroweed (*Isocoma tenuisecta*).

Riparian woodland, protection of which is the RNA's purpose, is in short supply; apparently there is much less than when the area was surveyed in 1969 (USDA—Forest Serv. 1969) (fig. 28). Flood waters have scoured much of the floodplain in recent years and left trash 15 feet high in trees that survived. Walnut and boxelder, listed in 1969, were not found in 1982. Trees in the 1.5 miles of main canyon now include only about 4 cottonwoods (*Populus fremontii*), 1 ash (*Fraxinus velutina*), and 20 or 30 sycamores (*Platanus wrightii*); also many hackberries (*Celtis reticulata*) but most of these are in one grove opposite Wild Horse Canyon. Of the side canyons, Pyrite Canyon has hackberries and large junipers. Faucet Canyon has a cottonwood and hackberries, and Wild Horse Canyon has several sycamores, an ash, and hackberries. (These details—although approximate—may be useful in some future decade if the RNA survives.)

A few stretches of riverbank, especially opposite Wild Horse Canyon, are thickly lined with 8-foot seepwillows (*Baccharis glutinosa*). Mudflats in October 1982 were covered with cupgrass (*Eriochloa gracilis*) and water speedwell (*Veronica anagallis-aquatica*). Sixweeks grama (*Bouteloua barbata*) grows on sand by the river. The desert shrubland best fits Küchler's Grama-Tobosa shrub-steppe (Type 58). The species-list above combines several distinct associations that form a mosaic in the RNA.

Henry (1981) discusses riparian vegetation of the Big Burro Mountains, including biogeographical aspects. Lowe (1964) describes both riparian and desert shrub vegetation of the sort found here.

Animals

Among those discussing the importance to a variety of wildlife of this part of the Gila and its floodplains are Dick-Peddie (1978), Hubbard (1977), R. Johnson et al. (1974), LaBounty and Minckley (1972), USDA—Forest Serv. (1975), USDI—Bur. of Reclamation (1982), USDI—Fish Wildlife Serv. (1976), and Zimmerman (1968).

Of the many birdlists for the Lower Gila River Valley in New Mexico, none seems to apply specifically to the RNA. Seven species listed by USDI—Forest Serv. (1969) for the RNA seem to be target species, rather than species sighted: peregrine falcon, zone-tailed hawk, gray hawk, black hawk, Rivoli's hummingbird, green heron, and Montezuma quail. Zimmerman (1968) lists, in addition, the following species that would be especially affected by destruction of riparian woodland in this part of the Gila: Abert's towhee, Lucy's warbler, Wied's crested flycatcher, white-winged dove, mourning dove, yellow-billed cuckoo, and Gila woodpecker. Threats to 4 of these species are discussed by Hubbard et al. (1979). Lists and observations of birds along the lower Gila above Red Rock, but not specifically including the hard-to-reach RNA, are reported by Baltosser (in Dick-Peddie 1978), Egbert (1981), Hubbard (1971, 1977, 1978), and Zimmerman (1968, 1972).

This permanent segment of the Gila is important as habitat for at least 5 native fish species (LaBounty and Minckley 1972, Hubbard et al. 1979, Koster 1957). Surviving between Cliff and Red Rock are spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitus*), both regarded as threatened or endangered; also longfin dace (*Agosia chrysogaster*), Gila coarse-scaled sucker (*Catostomus insignis*), and Gila mountain-sucker (*Pantosteus clarki*). Perhaps also in the RNA is the roundtailed chub (*Gila robusta grahami*), listed as threatened. Possibly the Gila chub (*Gila intermedia*) is also present, but there have been no recent collections (Hubbard et al. 1979).

Larger mammals seen in the natural area include javelina, mule deer, coyote, gray fox, black bear, mountain lion, and raccoon. Coues' whitetail deer and javelina have been reported nearby. There has been no survey for this area specifically. A 1972 tabulation by W. L. Minckley for the Hooker dam site, 19 miles upstream at the edge of a higher mountain range, is in USDI—Fish Wildlife Serv. (1976). Coatis reach their northern limit in these mountains (Kaufmann et al. 1976), and are presumably in the RNA. The last river otter reported in New Mexico was upstream of the RNA, toward Cliff (McClellan 1954). The hooded skunk is another likely species of interest.

The herpetofauna was studied by D. Johnson (1978). A tabulation by Minckley for the Hooker site is in USDI—Fish Wildlife Serv. (1976). Arizona coral snake and Gila monster are likely to be in the natural area.

Invertebrates have been surveyed for the Hooker site, 19 miles upstream (Cazier 1972) but not for the RNA.

Intrusions and Threats

Gila River RNA is out of the way and thereby well protected from casual intrusions. The area is open to cattle (USDA—Forest Serv. 1972), and browsing and trampling of cottonwood and other young trees is visible. Off-road vehicles, though forbidden south of the well-marked end of Forest Road 809, at least occasionally enter the RNA.

On the west bank at the edge of the only large alluvial fan in the RNA are the inconspicuous stone foundations of a building, apparently the 15-stamp mill built in 1885 to handle silver ore from the Telegraph Mine (west of the RNA) discussed by Gillerman (1964). Neither mine nor mill lasted long, but in 1903 "a small leaching plant with a 5-ton-a-day capacity" was erected on the same site. It too was not very successful (Gillerman 1964). The carefully built road from millsite south along the river is in good condition for 100 yards (fig. 27), but then continues as a pack trail, washed out in places, to the south edge of the RNA and beyond.

The Bureau of Reclamation, as part of the Central Arizona Project, is studying a proposal to dam the Gila 5 miles below the RNA. The Conner Dam reservoir would flood all of Gila Middle Box (USDI—Bur. of Reclamation 1982), including the RNA.

Research

Fish have been sampled in the RNA by the Bur. of Reclamation, the Fish Wildlife Serv., and by the New Mexico Department of Game and Fish. Zimmerman (1970) has studied birds and plants of the site. Others have inspected the area for raptor and other avian nest sites.

Maps

General: USDA—Forest Serv. 0.5-inch-to-1-mile series, Gila National Forest, 1974. Topographic: USDI—Geological Survey 1:62,500 series, Cliff Quadrangle, 1959. Geology: Hewitt (1959), Gillerman (1964), and Trauger (1972). Soils: Maker et al. (1971). Aerial photography: A black-and-white print, index #386 may be ordered from the Aerial Photography Field Office, ASCS-USDA, Salt Lake City.

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INKPOT RESEARCH NATURAL AREA

This 2-acre natural area has as its chief feature the Inkpot, a vertical-walled sinkhole 90 feet deep and 150 feet in diameter, currently with about 50 feet of water in it. The pond has been and may now be home to the Pecos gambusia and to *Batophora oerstedii*, a mostly-marine alga. Great horned owls and other birds nest on the cliff, and a variety of mammals and reptiles are present. The Inkpot is set in the Red Bluffs, here a 50-foot escarpment formed of the Permian Seven Rivers Formation.

Administration

Refuge Manager
Bitter Lake National Wildlife Refuge
P.O. Box 7
Roswell, NM 88201 (505) 622–6755

The Refuge is a unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1937; this part of it was designated a wilderness in 1970. The 2-acre (0.8-hectare) RNA was designated August 17, 1973. It was included with Lake St. Francis RNA in a Sinkhole Group as a national natural landmark in August 1980. When designated, this diminutive RNA was considered a supplement to or part of Lake St. Francis RNA; both were chosen mainly to preserve sinkhole ponds and their inhabitants.

The RNA is not marked on the ground in any way.

There has been no legal grazing by livestock in the area since 1955. Vehicles have been prohibited since wilderness designation in 1970. Deer hunting is allowed in season. The nearest non-federal minerals are 0.6 miles northwest, where rights in sec. 16 belong to New Mexico.

Location and Access

Inkpot Research Natural Area is in Chaves County at lat. 33°36′30″ N., long. 104°23′15″ W., in T. 8 S., R. 25 E., sec. 22 (E1/2 of the SE1/4 of the NW1/4) (fig. 29). There is no legal description of the 2 acres, but it is customarily mapped as a rectangle about 250 feet east-west and 350 feet north-south centered on the two Inkpots (the southern one now dry).

Inkpot RNA is in the Salt Creek Wilderness, which is between U.S. 285 and U.S. 70 in the north tract of Bitter Lake National Wildlife Refuge, 20 miles northeast of Roswell. It may be reached: (1) From U.S. 70; about 0.75 miles east of the Pecos River bridge; where Old Roswell-Clovis Highway joins U.S. 70 from the south, turn off to the north and follow the roadway 0.5 miles to its end in a small parking area (ignoring the first possible left turn onto a 2-track road). Thence walk 2.7 miles on bearing 350° True (338° Magnetic) to the Inkpot, keeping an eye out for rattlesnakes in the tall bunchgrass. (2) From U.S. 285; but this involves driving though private land on what may not be a public right-of-way: turn east on the wide, graded Red Bluff Road just south of the Salt Creek bridge, 7.5 miles north of the U.S. 285-U.S. 70 junction; follow the main road 8.0 miles east and northeast, there turn east on a bladed road; go 5.1 miles east; turn south for 2.6 miles; then short distances east and south to the Refuge boundary; thence walk the remaining 1.2 miles till the roadway ends atop the Red Bluff; the Inkpot will be visible to the right.

The nearest accommodations are in Roswell. Camping permits may be obtained from the Refuge Manager.

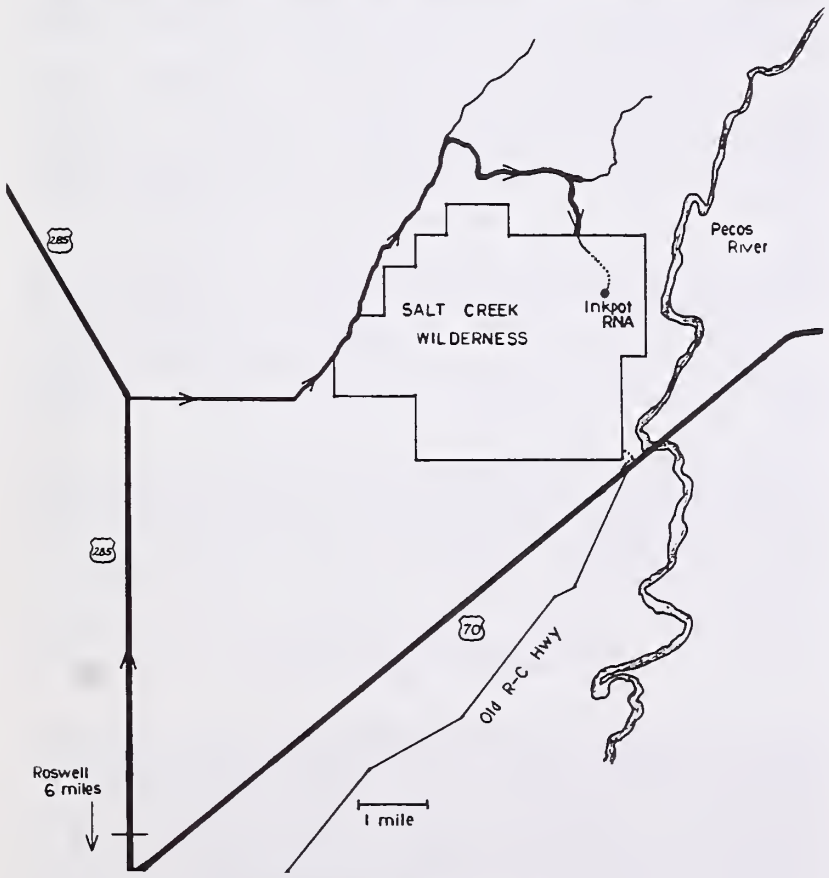

Figure 29. Inkpot RNA.

Climate

Climate of the area, warm and semi-arid, is discussed by Houghton (p. 1–2 in Lenfesty, 1983) and by Mourant (1963). Data from Refuge headquarters, 9 miles south, are the closest available, and are given in figure 11 under Bitter Lake RNA above.

Physiography, Geology, Soils

The Pecos Valley forms the westernmost section of Fenneman's (1931) Great Plains Province in New Mexico. Inkpot RNA drains to Salt Creek near its mouth in the Pecos River. The Red Bluffs mark the north side of the Salt Creek valley. Inkpot is at the foot of the Bluffs, here only about 50 feet high, 0.9 miles west of the Pecos. If the RNA boundaries are mapped as suggested above, the low elevation is 3,544 feet (1,080 m.) and the high 3,600 (1,097 m.).

Aside from the bluff, the main structural features are two sinkholes, the larger with walls vertical or partly overhung, 90 feet deep and 150 feet in diameter, currently containing about 50 feet of water. In 1937 this sink was overflowing, feeding the second, lower sink, which was also full and overflowing by a half-mile stream to a lake in the Salt Creek valley floor. In 1973 the lower sink contained several feet of water (Potter 1974). In 1982 it was dry, with sides about 15 feet high. The streambed that connected the Inkpots still drains a small area of the bluff and above, but is dry except after rains. For discussion of falling water tables in the Roswell Artesian Basin, see Lake St. Francis RNA in this report.

Walls of the upper Inkpot and most of the escarpment—that is, most of Inkpot RNA—are bare, soft, crumbly, dark red rock. This is the Seven Rivers Formation, the part of the Artesia Group directly overlying the Queen Formation (discussed under Lake St. Francis RNA), deposited mainly as evaporites at the edge of shallow Permian seas. Kelley (1971) describes this northern facies of the Seven Rivers as reddish gypsum, mudstone, and thin lithographic dolomite beds; cf. also Bachman and Stotelmeyer (1967) and Kelley (1972).

Bean (1951) describes the formation of sinkhole lakes in the Seven Rivers Formation (his Chalk Bluff Formation), and although he is writing of the Bottomless Lakes, 22 miles southward, the topographic and stratigraphic situations are like Inkpot's. According to Bean, artesian water is discharged at the hinge-line fractures at the base of the escarpment and dissolves gypsum from strata near the point of discharge, causing overlying beds nearest the river (in our case, nearest Salt Creek) to collapse. Surface runoff enlarges the sinks until they connect with channels leading from the artesian aquifer, allowing artesian water to rise in the sinks.

The early Permian Abo Formation is among the strata underlying Inkpot RNA that have potential for natural gas production (Broadhead 1982).

The Gypsumland soils, where soil is present at all, are thin and red on the severely eroded slopes. There are small pockets of other soils, probably Hollomex. The lower Inkpot contains new, deep alluvium, probably Reeves soil. See Lenfesty (1983) for soils.

Vegetation

Aquatic plants are presumably some of the same as those in Lake St. Francis RNA—*Chara*, *Potamogeton*, *Ruppia*, and the mainly-marine alga *Batophora oerstedii*—but we find no inventory for Inkpot RNA except the claim that *Batophora* is present. It is not easy to reach the water in Inkpot for sampling.

A few saltcedars (*Tamarix*) cling to the walls of Inkpot. Saltcedars have taken over the second, now-dry sink, and they line the streambed below it (figs. 30, 31).

Figure 30. Looking south across the Inkpot and dry sink into Salt Creek Valley. Saltcedars.

Figure 31. Forty-foot wall of the Inkpot; a saltcedar near the water.

Outside the watercourse, the small area's sparse vegetation includes many desert shrubs: snakeweed (*Gutierrezia*), creosotebush (*Larrea*), gyp bush (*Tiquilia*), mesquite (*Prosopis*), saltbush (*Atriplex canescens*), soapweed (*Yucca glauca*), prickly pear (*Opuntia engelmannii*), jointfir (*Ephedra viridis*). There is a scattering of grasses, mostly lining the small erosion channels (*Bouteloua*, *Sporobolus*, *Andropogon*, *Aristida*), and a few herbs such as gyp ringstem (*Anulocaulis gypsogenus*).

Animals

The minnow, Pecos gambusia (*Gambusia nobilis*), may already have been in Inkpot, but in any event was stocked there in 1973 by L. G. Kline (Bednarz 1975). A binocular survey by Bednarz from atop the wall in 1975 revealed no gambusia. Because it lacks shallows, Inkpot is not ideal habitat (Bednarz 1975).

Bats (unidentified) are common in the sink. Great horned owls and probably other raptors nest on the overhung walls of Inkpot. Lizards of several species scurry on the escarpment and sinkhole walls, and a roadrunner was seen pursuing them. Otherwise there seem to be no records specifically for these 2 acres. Reffalt (1968), quoted at length by Potter (1974), gives a list of mammals and herptiles for the Salt Creek Wilderness in which Inkpot RNA is located. Mule deer are the principle herbivores; coyotes are common and pronghorns rare in the vicinity of the RNA. A bird-list exists for the Refuge (USDI—Fish Wildlife Serv. 1984).

There have been suggestions over the years that a small bison herd—perhaps castrated males—should be planted in Salt Creek Wilderness. This has not happened.

Intrusions and Threats

Foundations of a cabin remain at the end of the roadway above the Inkpot, at the northeast corner of the RNA, but are scarcely visible. There is a small amount of litter, mostly decades old, around Inkpot.

State-owned mineral rights in Section 16, 0.6 miles northwest of Inkpot, could become a major problem if

developed; the impact of people on wildlife here would be serious. Oil and gas development along the Refuge boundary, one to two miles north of the RNA, is proceeding rapidly in 1983 (Broadhead 1982, 1983, and observations).

Falling water tables, due in part to increased use of water in the Roswell Artesian Basin, and perhaps partly due to declining precipitation, are the greatest threat to Inkpot RNA. The recording well discussed in this report under Lake St. Francis RNA is 13 miles southwest of Inkpot RNA.

Research

No studies other than the planting of Pecos gambusia are known.

Maps

Topographic: U.S. Geological Survey 1:24,000 series, Melena Quadrangle, 1962, and 1:100,000 series, Salt Creek sheet, 1979. Vegetation: Campbell (1937). Geology: Kelley (1971, 1972). Soils: Lenfesty (1983). Aerial photography: see Lenfesty (1983).

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JORNADA DEL MUERTO RESEARCH NATURAL AREA

On the western edge of the vast Jornada del Muerto, these 11,000 acres of sands are covered by sand sagebrush, broom pea, and dropseeds, with smaller areas of mesquite hummock, creosotebush, black grama, and free dunes. Pronghorn, mule deer, coyote, and a variety of smaller wildlife such as burrowing owls are common in the shrubland.

Administration

Refuge Manager
Bosque del Apache National Wildlife Refuge
P.O. Box 1246
Socorro, NM 87801 (505) 835–1828

Jornada del Muerto is one of 5 natural areas in Bosque del Apache Refuge, a 57,191-acre unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1939 on land purchased by the federal government in 1936 after many decades of

grazing and overgrazing. The approximately 11,000-acre (4,450-hectare) RNA was designated August 17, 1973. In 1975 the RNA was included by the Congress in a new 19,859-acre Little San Pascual Wilderness.

Our estimate of 11,000 acres for the RNA differs from two official estimates, 10,000 and more recently 9,133 acres. The Refuge Manager has written (in 1979 and 1982) that the south boundary is the actual road, used for patrol purposes, that heads east from just south of the Little Black Mesas. However, maps that the Fish and Wildlife Service has used for computation and for administration have shown another road (the one appearing on the 1948 Val Verde and San Antonio 15-minute topographic quadrangles), which no longer exists. It lay wholly north of the existing road, and the difference in position would account for much of the difference in acreage.

The Research Natural Area is closed to vehicles and to all mineral entry. It is open in season for deer, quail, and rabbit hunting. It has not been grazed legally for several years, but appreciable trespass grazing occurs. Even when the area was legally open there were rancher-Refuge battles over cattle numbers and times for grazing. The east (Refuge) boundary is well fenced and marked "unauthorized entry prohibited," but otherwise the RNA is not posted.

Location and Access

Jornada del Muerto Research Natural Area is in Socorro County, centered at lat. 33°47′15″ N., long. 106°49′45″ W. (fig. 32). Had the area been surveyed it would be in T. 6 S., R. 1 E., and the south edge of T. 5 S., R. 1 E. The north boundary lies along lat. 33°50′ N.; the west boundary goes south from 33°50′ N. along an old fence-line for 1.1 miles, then about southwest for 2.5 miles, then along a (mostly) buried pipeline south-southwest to an arroyo and road just south of conspicuous sandstone buttes; the south boundary follows that road easterly to the east boundary of the Refuge near its intersection with T. 6 S.-T. 7 S. line; and the east boundary runs north-northeast along the Refuge fence to point of beginning. The sandstone buttes—Little Black Mesas—are just outside the RNA. San Pascual RNA is adjacent to the south, and the roadway between them is the one labeled "Pack Trail" on the 1982 topographic map.

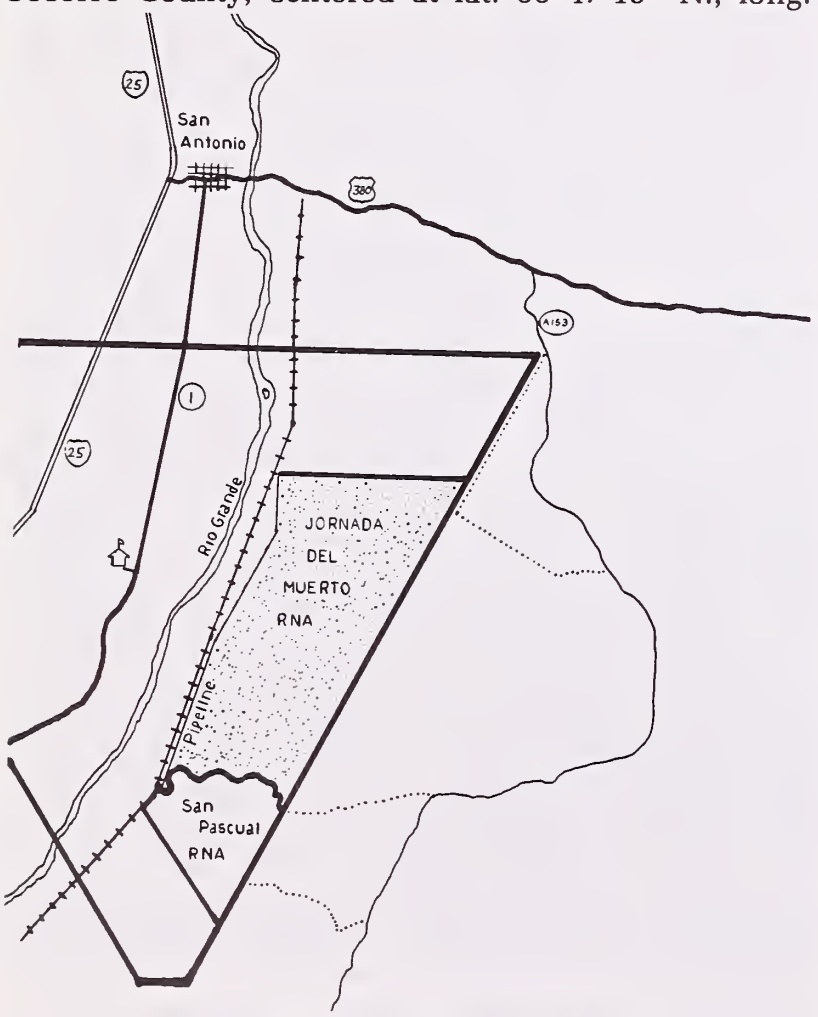

Figure 32. Jornada del Muerto RNA.

The east side of Jornada del Muerto RNA is reached by turning south from U.S. 380 on Socorro County A153: that junction is 7.4 miles east of the San Antonio exit from Interstate 25, or 5.7 miles east of the Rio Grande. From U.S. 380 drive south 5.8 miles, where turn west on a poorly bladed road. Pass a large metal stock tank at 6.9 miles from U.S. 380 and bear right (northwest) along the fence to the remains of a tank and windmill at the RNA and Refuge boundary, 9.3 miles from U.S. 380. This is the southeast corner of T. 5 S., R. 1 E., near the northeast corner of the natural area.

The southeast corner of Jornada del Muerto RNA is the northeast corner of San Pascual RNA, and may be reached by directions given under the latter.

Another approach, open only during daylight, is from Bosque del Apache Refuge headquarters. Follow directions to Apache Camp RNA given above under that heading; leave it on the left and cross the Main Conveyance Channel; jog north a few yards till a road goes east over the high dike; follow that road to the natural channel of the Rio Grande. In season—often September to February—the channel may be drivable; if not, it can usually be waded. The RNA is about 1.1 miles east of the river at this point. Do not drive into the wilderness area.

Accommodations are in Socorro.

Climate

The climate of Socorro County is discussed by Houghton (p. 7–9 in Maker et al. 1972): the area is warm and arid, with most of the 8 inches (200 mm.) of precipitation coming in late-summer thunderstorms. Data from Refuge headquarters, about 2.5 miles west of Jornada del Muerto RNA, are given in figure 7 above under Apache Camp RNA.

Physiography, Geology, Soils

This is the Mexican Highlands section of the Basin and Range Province. The west-sloping terraces that underlie the RNA, now 1 to 3 miles from the Rio Grande, were deposited in late Tertiary or Quaternary time. Elevation

in the natural area varies from 4,525 feet (1,379 m.) along the western border to 4,830 feet in the northeast and 4,855 feet (1,480 m.) in the southeast corner.

The Jornada del Muerto—the great trough and plain in which the RNA is located—extends at least 150 miles from Socorro south through Sierra to Doña Ana counties; or in Fenneman's (1931) interpretation, the whole 260 miles from Albuquerque to El Paso. The Spanish Trail to Santa Fe followed much of the Jornada, and death by thirst and by the hands of robbers is said to have marked the route with bones (Keyes 1905), hence the name, "journey of the dead man." Surface drainage in most of the RNA is to the Rio Grande, but several parts drain east to the Jornada, which here has no outlet, and the northeastern 1,000 acres drain to a slight depression within the RNA.

Sand dunes cover 40 acres or so in the south; there is poorly anchored sand in most parts of the RNA, and blowouts to 60 feet in diameter are scattered in the sandy areas. In the southwestern section there are gravelly ridges with no sand.

There is no permanent water in the natural area except at Antelope Well, a windmill, drinking trough, and small overflow pond in the east-center of the area, maintained by Refuge personnel.

There are a few rock outcrops along west-facing slopes through the north-south center of the RNA. These are apparently Tertiary or Pleistocene rhyolites that have been assigned to the Santa Fe Group (Dane and Bachman 1965). In the southwestern corner of the natural area, and more prominently just outside it, are outcrops of red Baca Formation sandstone, of early Tertiary age. Outside the RNA the sandstone rises in 150-foot buttes, the Little Black Mesas.

Soils are of the Berino-Bluepoint-Onite Association (Maker et al. 1972), classified as an Aridsol of Haplargids-Torripsamments construction. These are deep soils in which thin, sandy loams cover several feet of subsoil that varies from clay loam to sand. Minor, even sandier members of the association, such as Pintura soils, may be prominent in the RNA.

Vegetation

Sand sagebrush (*Artemisia filifolia*) and broom pea (*Psorothamnus* or *Dalea scoparia*) dominate the sandy sites—80 to 90% of the Research Natural Area (fig. 33). They occur either together or with one or the other the single dominant in patches of one to several acres. Between shrubs, dropseeds are common: *Sporobolus cryptandrus*, *S. contractus*, and, on the deepest sands, *S. giganteus* to 6 feet tall. Indian ricegrass (*Oryzopsis hymenoides*) occurs with the dropseeds. Isolated or in small patches over most of the RNA are junipers (*Juniperus monosperma*), soapweeds (*Yucca glauca*), fourwing saltbush (*Atriplex canescens*), mesquite (*Prosopis glandulosa*), snakeweed (*Gutierrezia sarothrae*), and other subshrubs of the composite family. In the north mesquite is common, holding sand in hummocks, with broom pea and sand sagebrush between hummocks (fig. 34). When moisture permits, many annuals cover the sand, such as

Figure 33. Sand blowout with broom pea, sand sagebrush, and dropseed. Jornada del Muerto RNA.

Figure 34. Mesquite hummock with dropseeds and broom pea. Jornada del Muerto RNA.

devil's-claw (*Proboscidea*) and heliotrope (*Heliotropium*).

Small areas around Antelope Well are dominated by creosotebush (*Larrea tridentata*) and, on ridges, by jointfir (*Ephedra*). There is some black grama (*Bouteloua eriopoda*) near the southeast corner of the RNA.

A small, artificial pond by Antelope Well has cattails (*Typha*) and saltcedar (*Tamarix*). Saltcedars have been cut around a small playa there. They also grow near a dam in the southwest corner of the RNA.

Probably all the area suffers from past overgrazing, but there is no control area for comparison. Many acres of the RNA near the now-abandoned Fite Well near the northeast corner still have annual weeds as their main cover.

Donart et al. (1978) map this as Chihuahuan Desert Grassland: Mixed Dropseeds-Black Grama Association (Type CG4a), which includes sand sagebrush locally. Their Type CG4c, Mixed Dropseeds-Indian Ricegrass, is perhaps more appropriate for these sandy slopes.

Animals

Pronghorns and black-tailed jackrabbits are the conspicuous herbivores; mule deer are also here. Scaled

quail are common, and there are burrowing owl nests. Golden eagles are not uncommon, though red-tailed hawks are more regularly present. Blowouts and dunes are criss-crossed with tracks of insects, lizards, snakes, quail and other birds, pronghorns, and coyotes.

Studies from farther south on the Jornada plain are helpful for animal ecology (e.g. Howard et al. 1973, Whitford 1976), but do not deal with the broom pea-sand sagebrush community, on which nothing has been published.

Archaeology

The San Pascualito Pueblo ruins on Little Black Mesa are about 1,300 feet outside the RNA. Surveys in 1932, 1940, and 1978 lead to belief that the pueblo was abandoned by 1359 A.D., with possible brief re-occupation in the fifteenth century. Unpublished data are available at the Museum of New Mexico Laboratory of Anthropology in Santa Fe under Site No. 756.

Intrusions and Threats

A 600-yard-long road leads from the west to Antelope Well, a conspicuous windmill, tank, and pond in the east center of the RNA. The pipeline buried in 1954 along part of the west boundary is above ground from place to place, but neither it nor the seldom-traveled two-track road that accompanies it is conspicuous. Occasional small signs mark the pipeline route. Although 1948 topographic maps show two roads across the RNA, they are now difficult or impossible to find.

In the extreme southwest of the area on San Pascualito Arroyo is a 20-foot-high stone dam and pond area dating from the 1930's. It is filled in and covered by half an acre of saltcedar. The pond holds surface water for only a short time after rains.

Signs of trespass cattle are common.

Research

None is known.

Maps

Topographic: USDI—Geological Survey 1:24,000 series, San Antonio Quadrangle, 1982; and for the southernmost half-mile also the Little San Pascual Quadrangle, 1982. Previous topographic maps and the 1979 Bureau of Land Management quadrangle are excessively misleading as to roads. Eastern approaches to the Refuge are covered on the Cerro de las Campana 1:24,000 Quadrangle. Soils: Maker et al. (1972). Geology: Bachman and Stotelmeyer (1967), Weir 1965.

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LAKE LUCERO RESEARCH NATURAL AREA

Lake Lucero, the usually dry remnant of Pleistocene Lake Otero, occupies the hot, dry bottom (3,900 feet elevation) of the Tularosa Basin. This salt-encrusted plain "grows" selenite crystals, rather than vegetation, from groundwater. Alkali sacaton and Chihuahuan Desert shrub steppe grow west of the Lake.

Administration

Superintendent
White Sands National Monument
P.O. Box 458
Alamogordo, NM 88310 (505) 437–1058

White Sands National Monument, established in 1933, is a 230-square-mile unit of the National Park System administered by the National Park Service, U.S. Department of the Interior. Lake Lucero RNA was established September 26, 1969, with an area of 5,760 acres. It is in the western part of the Monument that is governed by a co-use agreement with the U.S. Army, 35% of whose missile flights at White Sands Missile Range overfly the co-use area.

Hunting, livestock grazing, vehicles, and collecting are prohibited in the RNA. The land is withdrawn from all mineral entry. Missiles and visitors are permitted under strict controls aimed at keeping them apart. A clause in the co-use agreement states that missile impacts in the Lake Lucero crystal beds are to be avoided.

Location and Access

Lake Lucero Research Natural Area is in eastern Doña Ana County within White Sands National Monument and White Sands Missile Range. It is centered at lat. 32°42′30″ N., long. 106°27′00″ W., (fig. 35), and comprises secs. 16, 20, 21, 29, and 32 of T. 18 S., R. 5 E., and secs. 3, 4, 5, and 10 of T. 19 S., R. 5 E.—9 square miles (5,760 acres or 2,331 hectares).

Monument headquarters are on U.S. 70 and 82, 15 miles southwest of Alamogordo or 63 miles northeast of Las Cruces.

The RNA may be visited only with permission of White Sands National Monument personnel. Vehicular access requires permission and escort also from White Sands Missile Range, U.S. Army. Public tours from Monument

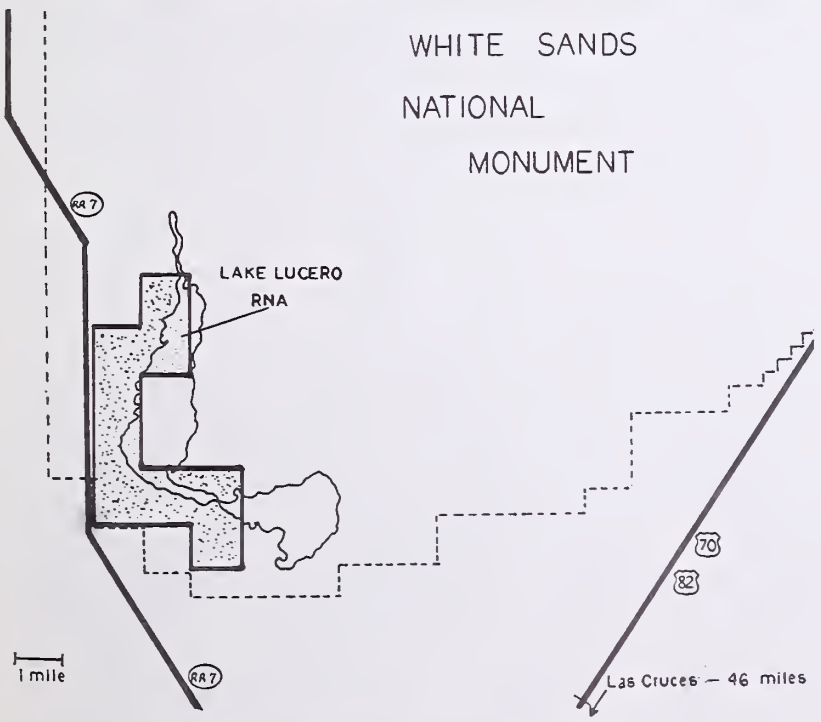

Figure 35. Lake Lucero RNA.

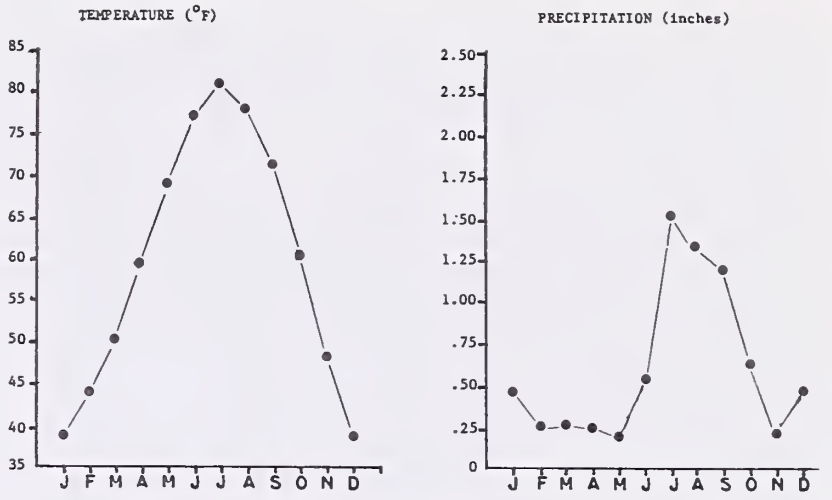

Figure 36. Climate of Lake Lucero RNA.

headquarters to Lake Lucero are arranged on a bimonthly basis. Their route is Missile Range Road 7 from its intersection with U.S. 70–82 15 miles north to the west side of Lake Lucero.

Accommodations are in Alamogordo or Las Cruces. The nearest campgrounds are 35 miles northeast in Lincoln National Forest and 30 miles southwest at Aguirre Springs. Overnight hiking in the Monument requires clearance and registration at Monument headquarters.

Climate

Lake Lucero is in a hot, arid valley with a daily temperature range that often exceeds 60° F. Arctic cold and Gulf of Mexico rains tend not to penetrate the Tularosa Basin: summer air from the Gulf drops 50% more precipitation on the far, eastern side of the Sacramento Mountains than on the western. Regional warmth and aridity are compounded by the reflective properties of gypsum, which cause warmer days and cooler nights here. In the 1970's precipitation averaged 7.8 inches (200 mm.) with a 33% standard deviation. Mean annual temperature was 60°F (15.5°C), with a high of 110°F (43.3°C) and low of –14°F (–25.5°C) at Monument headquarters. Annual potential evapotranspiration is about 30 inches (762 mm.). Climate is discussed by Neher and Bailey (1976), Reid (1980), and other sources listed below. Monthly averages from the Monument weather station (Index No. 9686) are shown on figure 36.

Physiography, Geology, Soils

The Tularosa Basin, in which the White Sands are located, occupies a much-faulted graben between the San Andres Mountains on the west and the Sacramento Mountains on the east. The basin, fully described by Meinzer and Hare (1915), is a flat-floored bolson extending 125 miles north-south in New Mexico. It is classified by Fennemen (1931) in the Sacramento Section of the Basin and Range Province.

The alkali flat in whose southern end Lake Lucero is situated covers about 165 square miles, with gypsum dunes to 100 feet high to the east and alluvial slopes

derived from the San Andres Mountains to the west. Elevation of the playa is about 3,900 feet (1,189 m.) throughout. West of the lake the RNA rises to 4,025 feet (1,227 m.).

Pleistocene Lake Otero occupied the Tularosa Basin during the period 24,000–4,000 years before present (Herrick 1904, Hendrickson 1983). Lake Lucero, usually surface-dry but with the soil wet, is its depauperate descendant. "The alkali flats practically represent the water table laid bare by wind erosion" (Fenneman 1931). This groundwater is too alkaline for drinking, with pH about 8, and about 35,000 mg. per liter of dissolved solids including sulfate 1.85%, sodium 1.4%, chloride 1.8%, and magnesium 0.3% of total weight. Hydrology here has been well studied, notably by Meinzer and Hare (1915), Kottlowski (1958), and Allmendinger and Titus (1973). The majority of the gypsum in the White Sands was undoubtedly derived from the primary evaporites of Lake Otero. Groundwater discharging at Lake Lucero may have produced enough crystalline gypsum to make up as much as 33% of the White Sands (Allmendinger and Titus 1973).

Shores of the lake within the RNA are covered with brownish-golden selenite crystals, colored by silt, which flake in rhombic crystals similar to mica (fig. 37). Some crystals are several feet long, and were used in early days for windows. Crystals continue to form from calcium sulfate brought by groundwater.

Geology of the Tularosa Basin is well known (Herrick 1904, Meinzer and Hare 1915, Sandeen 1954, summarized by Dodge 1971). The Permian Yeso and San Andres Formations underlie this part of the Basin and are the source of most of the gypsum there. In the San Andres Mountains just west of the RNA, 40% of the 1,580-foot-thick section of the Yeso (= "gypsum") Formation is gypsum. These are Permian strata deposited in the Delaware Basin during that period.

No bedrock is exposed in the RNA. Overlying bolson deposits may be 6,000 or more feet thick, comprising red clay and silt intercollated with sands, conglomerates, and gypsum and salt beds.

Figure 37. Selenite crystal bed, Lake Lucero. (Courtesy of White Sands National Monument.)

Three soil types are mapped for the RNA, all classified in the Gypsum Land great group (Neher and Bailey 1976). Predominant along the lakeshore is the Marcial-Uber Association, including 55% Marcial silty clay loam and 35% Uber silt loam. On alluvial slopes to the west and south is the Mimbres-Glendale Association with 55% Mimbres silt loam and 25% Glendale silt loam. At the northern tip of the RNA an area is mapped as Doña Ana Complex Dune Land; but recognizable dunes begin about 1,800 feet east of the RNA.

Vegetation

Although plants of the Tularosa Basin and of the Monument as a whole are well documented (Shields 1956, USDI—Nat. Park Serv. 1973, U.S. Army 1975, Reid 1979–80), available data relating plants specifically to the alkali flat at Lake Lucero are few. Emerson (1935) states that only scattered individuals of sand verbena (*Abronia angustifolia*) and iodine bush or burroweed (*Allenrolfea occidentalis*) grow on the alkali flat; only the latter was common in 1984. Reid (1980b) lists an association including mainly iodine bush and also four-wing saltbush or chamiza (*Atriplex canescens*), seepweed (*Suaeda torreyana*), saltcedar (*Tamarix gallica*), and alkali sacaton (*Sporobolus airoides*) for Lake Lucero (fig. 38).

The RNA extends up to a mile south and west of the lake flat onto the 1–5% east- and north-facing slopes of alluvial deposits. There, in what Neher and Bailey (1976) call clay grasslands, are alkali sacaton, tobosa (*Hilaria mutica*), four-wing saltbush, creosotebush (*Larrea divaricata*), and burrograss (*Scleropogon brevifolius*). Thus the predominant vegetation type of the RNA is Küchler's Type 58, grama-tobosa shrub steppe.

Other plants that are near and probably are within the RNA (Neher and Bailey 1976) include coldenia (*Tiquilia hispidissima*), knifeleafcondalia (*Condalia spathulata*), mesquite (*Prosopis glandulosa*), jointfir (*Ephedra torreyana*), gyp grama (*Bouteloua breviseta*), rosemarymint (*Poliomintha incana*), saltgrass (*Distichlis spicata*), and vine mesquite (*Panicum obtusum*).

The rosy hue that Lake Lucero sometimes takes on when wet is due to growth of purple sulfur bacteria (Dodge 1971 and Hendrickson 1983).

Animals

Twelve snake, 11 lizard, and 1 turtle species are known for the vicinity (Bugbee 1942, Dixon and Medica 1967, USDI—National Park Service 1973). On the white dunes of the Monument some species are much whiter than elsewhere, and subspecies have been described; but this may not be relevant to the RNA itself. Noteworthy are Cowles prairie lizard (*Sceloporus undulatus cowlesii*) and the bleached earless lizard (*Holbrookia maculata ruthveni*).

Mammals are well studied in the Monument but not in the RNA (Dice 1930, Benson 1933, USDI—National Park Service 1973). Of rodents, at least *Perognathus*

penicillatus, *Dipodomys merriami*, *Onychomys torridus*, *Neotoma micropus*, and *Thomomys bottae* (*T. baileyi*) would be expected west of Lake Lucero (Blair 1943). Coyote, kit fox, desert cottontail, and black-tailed jackrabbit are present, as is the introduced gemsbok (Reid and Patrick 1983).

Stroud (1950) lists 8 insect species from the RNA.

Archaeology

A large unit house of the El Paso phase of Mogollon culture, dating from about 1250 A.D., is in Section 5 of the RNA. Dwellings and accompanying facilities may have occupied 100 acres. The pueblo has been exposed by erosion and material including Brown Ware pottery is scattered over half the section. Two human burial sites have been excavated (Eidenbach and Wimberly 1980).

This is Human Systems Research (Tularosa) site 702–1 and Museum of New Mexico (Santa Fe) site 21162.

Intrusions and Threats

Old roads in south and west parts of Lake Lucero RNA are said to have disappeared, or nearly so. However, the wilderness study (USDI—Nat. Park Serv. 1969) mapped 1.3 miles of road in Section 32 that had not appeared in older maps. Missile Range Road 7 runs along 4 miles of the RNA's western border. The natural area is not fenced. There are single traverse stations (concrete posts?) in Sections 5 and 10. Missile Range structures in the co-use area may also be in the RNA (U.S. Army 1975, USDI—Nat. Park Serv. 1971). Remains of corrals and buildings are west of the lake (Hendrickson 1983), and the area was seriously overgrazed.

Location within White Sands Missile Range as well as within White Sands National Monument in some ways gives extraordinary protection to the RNA. Nearly all visitors are in bi-monthly tour groups accompanied by military police and Monument rangers. Crystal collecting by military personnel is known but thought not to be common.

Figure 38. Selenite and dropseeds. Lake Lucero RNA. (Courtesy of White Sands National Monument.)

The number of planned missile impacts in the co-use area as a whole—74,849 acres—was reduced from an average of 25 to 30 per year to 10 in 1972, 9 in 1973, and 4 in 1974 (U.S. Army 1975). None are planned for the Lake Lucero area itself, but they occur; impacts during 1963–1971 are mapped by USDI—Nat. Park Serv. (1971). Impacts include space vehicles and parts of towed targets. Debris is cleared by helicopter under supervision of National Park Service personnel. Missile impacts have been studied by Moore (1976) and the degree of intrusion on the Monument is discussed by Niklaus (1977). Missile activity was given as the reason for a recommendation that none of the Monument be designated wilderness (USDI—Nat. Park Serv. 1971).

Flights in addition to missiles include Missile Range planes and 4 to 10 helicopter flights over Monument land daily, and Holloman Air Force Base aircraft based 19 miles northeast of the RNA.

Industrial development—a multi-billion-dollar "energy park"—is contemplated near Alamogordo, some 25 miles northeast. Possible heavy use of Tularosa Basin groundwater would have serious impact on Lake Lucero (cf. Allmendinger and Titus 1973, and literature cited by Garza and McLean 1977 and in current Basic Data Reports of the New Mexico State Engineer).

Introduced organisms that alter ecological balance of the RNA are saltcedar (Reid 1980) and gemsbok (Reid and Patrick 1983, Saiz and Decker 1975).

Research

Allmendinger studied the source of sulfate for selenite crystals formed at Lake Lucero (Allmendinger and Titus 1973). R. Anderson studied mineral content of water at Lake Lucero in 1965 (Monument file N22 WHSA). The Army contracted core samples at the Lake in 1966 (see the same file). W. H. Reid and his students of University of Texas—El Paso continue to produce reports on vegetation and other aspects of ecology of the Monument, including Lake Lucero; see "References" below. Stroud (1950) looked at insects of the RNA. For archaeological research see Eidenbach and Wimberly (1980). Other research in the Monument has concerned the RNA at least incidentally.

Maps

Administrative: see U.S. Army and USDI sources cited below. Topographic: USDI—Geological Survey 1:24,000 series Lake Lucero Quadrangle, 1948; 1:100,000 series White Sands sheet, 1982. Geology: USDI—Geological Survey 1:500,000 Geologic Map of New Mexico, 2 sheets, 1965, by Bachman and Dane, and N.M. Bur. Mines & Min. Resources Geol. Map 14, 1960, by Kottlowski. Soils: Neher and Bailey (1976). Vegetation: Reid (1980). Aerial photography: Neher and Bailey (1976), Hendrickson (1983) and U.S. Army (1975).

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LAKE ST. FRANCIS RESEARCH NATURAL AREA

More that 30 sinkholes puncture the gypsum-rich bedrock of these otherwise level 700 acres. Several holes contain salt-tolerant fish: the endangered Pecos gambusia, the Pecos pupfish, green sunfish, and others. The green filamentous alga *Batophora oerstedii*, otherwise known from the Gulf of Mexico, is common here. Terrestrial vegetation is desert shrub steppe dominated by alkali sacaton and saltgrass on flats and grama and other grasses on uplands, with several obligate gypsophiles.

Administration

Refuge Manager
Bitter Lake National Wildlife Refuge
P.O. Box 7
Roswell, NM 88201 (505) 622–6755

The Refuge is a unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. Bitter Lake Refuge was established in 1937. The 700-acre (283-hectare) research natural area was designated August 17, 1973. It was made a National Natural Landmark in August 1980.

Entry requires a permit from the Refuge Manager. Hunting, fishing, swimming, and livestock grazing are prohibited. Mineral rights in Section 32, which contains 360 acres of the RNA, belong to New Mexico, only the surface rights having been purchased by the federal government in 1937.

North and west borders of the RNA coincide with the Refuge boundary, which is fenced and posted. The research natural area is not marked as such, but there are "no unauthorized entry" signs at likely routes into the area.

Location and Access

Lake St. Francis Research Natural Area is in Chaves County, centered at lat. 33°29′15″ N., long. 104°25′10″ W., (fig. 39) in T10S R. 25 E., secs. 4 and 5 and T. 9 S., R. 25 E., sec. 33 and, mainly, sec. 32. The boundary is described from the northeast corner of T. 9 S., R. 25 E., sec. 32: E. 1,320 feet thence S.7,260 feet thence W. 2,640 feet thence N. 660 feet thence W. 2,640 feet thence N. 3,960 feet thence E. 1320 feet thence N. 1,320 feet thence E. 1,320 feet thence N. 1,320 feet thence E. 1,320 feet to point of beginning.

The RNA is 2 miles north-northwest of headquarters in the south tract of Bitter Lake National Wildlife Refuge, 14 miles northeast of Roswell. Access to the Refuge is either from U.S. 380, 3.7 miles east of the center of Roswell, or from U.S. 70–285 4 miles north of the center.

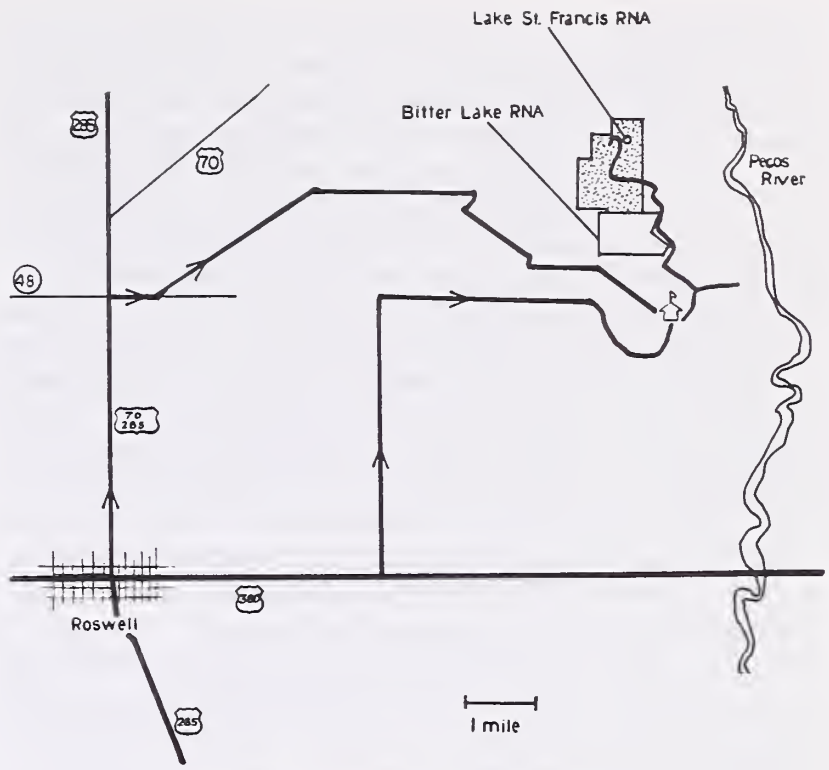

Figure 39. Lake St. Francis RNA.

Given an entrance permit, the RNA is reached on graded roads that lead north through the Refuge headquarters area.

The nearest accommodations are in Roswell.

Climate

The region is warm and semi-arid, with precipitation about 10 inches (250 mm.) in the Refuge or 13 inches (330 mm.) from Roswell data over a longer period. More than half the precipitation comes during the summer, mostly in thundershowers. Climate is discussed by F. E. Houghton (in Hodson et al. 1980) and by Mourant (1963). Monthly data from Refuge headquarters are given in figure 11 above under Bitter Lake RNA.

Physiography, Geology, Soils

The Pecos Valley is at the western border of the Great Plains Province. These valley plains presumably resulted from erosion by the Pecos River of a formerly broader Llano Estacado, now 45 miles to the east. Bitter Lake Refuge is within the Roswell Artesian Basin, which receives water from highlands to the west. The RNA is just west of the current floodplain of the Pecos River and is 1.25 miles west of the river.

Within the RNA elevation rises gradually from 3,495 feet (1,065 m.) in the southeast corner to 3,543 feet (1,080 m.) in the northwest, an average slope of less than 1%. Several areas appear flat, and about 40 acres in the northeast of the RNA form a shallow depression with no external drainage. Twenty-nine small, round, steep-sided sinkholes in the RNA have been assigned numbers (Bednarz 1975) and there are several others. All once held water, and several still do (fig. 40). The largest is Lake St. Francis, 200 feet across with sides (in late 1982) 15

feet high above the 44-foot-deep water. Sinks form by collapse of overlying strata into hollows formed by solution of pockets of gypsum, and may exceed 100 feet in depth (Bean 1951). One pothole appeared during the 1930's, and two not-yet-collapsed domes are known in the RNA.

Water level varies from one sink to another, but all are alike in that levels have, on average, been going down for many years. Variations in water level depend on the artesian head, which in turn depends on recharge in the Hondo and adjacent basins to the west, mostly in Lincoln County (Bean 1951, Fiedler and Nye 1933, Mourant 1963). Quality of the brackish water varies. Dissolved solid concentrations as high as 22,550 mg./liter have been measured, but at least 5 sinks and Dragonfly Spring—the waters supporting Pecos gambusia in the RNA in 1975—had solids at 5,050 mg./liter or less (Bednarz 1975).

Bitter Creek (or North Fork of Lost River), a small, intermittent stream, flows southward through the west side of the natural area into Bitter Lake, which lies just to the south (see Bitter Lake RNA in this report). Streamflow is augmented in the southeast part of Lake St. Francis RNA by Dragonfly Spring.

Surface strata are Pleistocene and Recent gypsiferous alluvium, including terrace gravels in the southern part of the RNA. Gypsiferous bedrock is closely underlying in most parts of the area, and is exposed in the sinks. These strata are siltstones and gypsum of the Queen Formation, deposited along with other members of the Artesia Group during Permian times in a shelf sea extending north from the deeper Delaware Basin (Kelley 1971). In sinks the rock layers are usually coated with recent gypsum deposits from the water.

Of deeper underlying strata the early Permian Abo Formation, some 4,400–5,100 feet below the surface, is of particular interest: 3 wells in the township (T. 9 S., R. 25 E.) are yielding natural gas, and exploration continues apace (Broadhead 1982). A small oil-producing field exists 2.5 miles south of the RNA.

Sand, clay, stone, and gypsum are quarried in the vicinity.

Soils are mapped as Holloman and Gypsumland of the Gypsiorthids, Torriorthents, and Gypsumland great groups. In general this map unit contains 60% Holloman loam (some with a thick A–2 solum), 30% Gypsumland, and 10% other soils (Hodson et al. 1980). The moisture regime is borderline between aridic and ustic-aridic. Abundant gypsum in all these soils is highly susceptible to solution. White gypsum crusts form from evaporation in flat areas.

Figure 40. A sinkhole, with old channels exposed by falling water levels. The larger shrubs are saltcedars. Lake St. Francis RNA.

Vegetation

Aquatic plants are mainly the structurally complex alga, musk grass or stonewort (*Chara*); pondweed (*Potamogeton pectinatus*); ditch grass or wigeon grass (*Ruppia maritima*); and, of special interest, the green alga *Batophora oerstedii* (order Siphonocladales), of which the known distribution includes only coastal waters and lagoons from Bermuda to the Gulf of Mexico plus these sinkholes.

At the edges of ponds and along Lost River are often a few rushes (*Scirpus*), cattails (*Typha*), reeds (*Phragmites*), and the invasive, Old World saltcedar (*Tamarix*) (fig. 40). Some of the newly dry sinks also have these 4-to-10-foot-high plants.

Salt flats and depressions are dominated by alkali sacaton (*Sporobolus airoides*) and saltgrass (*Distlichis spicata*), with scattered shrubs including saltcedar, baccharis (*Baccharis emoryi and B. glutinosa*), and *Clappia suaedifolia* (*Pseudoclappia arenaria*) (fig. 41). An unusual assemblage of herbs includes sea lavender (*Limonium limbatum*), sea purslane (*Sesuvium verrucosum*), iodinebush (*Allenrolfea occidentalis*), threadleaf (*Sartwellia flaveriae*), and a beautiful, occasionally bush-like centaury (*Centaurium texense*).

Uplands are covered with grasses and shrubs, the former commonly gramas (mainly *Bouteloua breviseta*; also *B. gracilis, B. eriopoda, B. hirsuta, B. barbata*), tobosa (*Hilaria mutica*), sacatons (*Sporobolus airoides* and *S. wrightii*) and dropseed (*S. cryptandrus*), sprangletop (*Leptochloa dubia*), fluffgrass (*Erioneuron pulchellum*), ring muhly (*Muhlenbergia torreyi*), and three-awns (*Aristida* spp.). Shrubs and subshrubs include snakeweed (*Gutierrezia*), soapweed (*Yucca*), gyp bush (*Tiquilia*), saltbush (*Atriplex canescens*), jointfir (*Ephedra*), rayless goldenrod (*Isocoma wrightii*), mesquite (*Prosopis*), and saltcedar. Gyp ringstem (*Anulocaulis gypsogenus*) is among several interesting herbs.

Küchler (1975) and Donart et al. (1978) map potential natural vegetation for Bitter Lake Refuge as Chihuahuan

Desert Shrub (Küchler's Type 44, Creosotebush-Tarbush), but the characteristic species are scarcely represented now. More appropriate, perhaps, is the gypsum facies of Donart's Sacaton-Tobosa Association (Type CG4d), with alkali sacaton dominant in depressions and gramas and tobosa on uplands.

Animals

Of prime interest is a minnow, the Pecos gambusia (*Gambusia nobilis*), listed as endangered by federal and state authorities and surviving only on the Bitter Lake Refuge, at Blue Spring in Eddy County, and in a few Texas localities (Bednarz 1975, Hubbard et al. 1979). Bednarz estimated that 33,500 individual gambusias existed in the Lake St. Francis area. Because there have been transplants, the current distribution of these and other fish in the RNA is not wholly natural (Bednarz 1975). Bednarz speculates that the failure of Pecos gambusia to become established in Lake St. Francis itself, though the water seems suitable, was predation by the green sunfish (*Lepomis cyanellus*).

The RNA also provides important habitat for the Pecos pupfish (*Cyprinodon pecosensis*), no longer listed as threatened because its habitats in the Pecos drainage seem, collectively, to be relatively secure (Bednarz 1975, Echelle and Echelle 1978, Hubbs and Echelle 1972, Kodric-Brown 1977).

Many terrestrial bird species nest in the area (USDI—Fish and Wildlife Serv. 1984), for instance great horned owls on the bank of Lake St. Francis. Desert cottontail, black-tailed jackrabbit, striped skunk, raccoon, bobcat, coyote, gray fox, badger, and long-tailed weasel are among the mammals noted for this part of the Refuge. Reffalt (1968), quoted at length by Potter (1974), lists many vertebrates known in the northern tract of Bitter Lake Refuge; probably nearly all are at least occasional visitors to Lake St. Francis.

Intrusions and Threats

Well-graded but lightly-traveled roads crisscross the research natural area: mainly 3 east-west roads across the north, south center, and south, a road along the whole east side, and a central road from the middle east-west road north to Lake St. Francis. Ditches several feet deep, with excavated earth mounded at their sides, connect the 30 largest sinks for the purpose of taking overflow to the Refuge impoundments; but water levels have been well below ditch levels for many years.

Figure 41. Alkali sacaton and a little saltgrass. Lake St. Francis RNA.

There has been a problem with swimmers trespassing in summer. Results are litter, disturbance of wildlife such as nesting owls, and roiling of water that can prevent breeding by minnows (letter from A. Kodric-Brown included in Ligon 1976).

Invasion by saltcedar and to a much lesser extent by Russian olive might be considered an intrusion. Some eradication of saltcedar has been attempted, but none is now planned.

Mineral rights to 360 acres of the RNA are owned by the state and the township is being explored for natural gas with some success. A similar situation led to a trespass road and drilling in the northern tract of the Refuge in 1982.

Most pressing, but perhaps politically intractable, is the problem of drying springs and ponds and increased salinity of groundwater that supplies surviving springs and ponds. A heavy rainstorm 70 miles west of Bitter Lake Refuge can raise water levels appreciably. An exceptional year of precipitation in the Hondo Basin, for instance 1941 with twice the normal amount, raised water levels 14 to 17 feet (Bean 1951, Mourant 1963). The usual story, however, is not up but down; even a general physiography text of 50 years ago (Fenneman 1931) noted the falling watertable of the Roswell Artesian Basin. The watertable in the recorder well closest to Lake St. Francis—6 miles southwest—declined 25 feet in 19 years, 1959–1977 (Hudson 1980). Mourant (1963) states that the decline of the watertable in the San Andres Formation—the region's principal aquifer—can be expected to continue at a rate of 1.5 to 2 feet per year if pumpage and recharge remain the same. But they have not remained the same; in the Pecos Basin water depletions for irrigated agriculture increased by 30,000 acre-feet per year, or 11%, during 1970–1980, and industrial-mineral use increased by 8,000 acre-feet, or 185%, during that period (Sorenson 1982). Clearly major values of the research natural area are in peril.

Research

Research on minnows in the RNA is mentioned above. The New Mexico Native Plant Society is studying changes in vegetation since the survey by Campbell (1937).

Maps

Topographic: U.S. Geological Survey 1:24,000 series, Bitter Lake Quadrangle, 1962, and 1:100,000 series, Roswell sheet, 1979. Geology: Kelley (1971). Vegetation: Campbell (1937). Soils: Hodson et al. (1980), but note that

on Map Sheet 3 Lake St. Francis is the 2.6-mm.-diameter feature 5 cm. southwest of the feature *labeled* Lake St. Francis. Aerial photography: Hodson et al. (1980).

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MATHERS RESEARCH NATURAL AREA

Shinnery vegetation anchors the sands of these 242 acres inhabited by lizards, prairie chicken, pronghorns, mule deer, and coyotes. Dominant plants are 2-foot-high shrubs, shin oak and sand sagebrush, and a 5-foot-high grass, sand bluestem. Livestock and vehicles are excluded from a 96-acre fenced area; the remaining acreage is open and grazed year-round.

Administration

Area Manager
Roswell Resource Area
Bureau of Land Management
1717 W. Second Street
P.O. Box 1397
Roswell, NM 88201 (505) 622–7670

Mathers RNA is in the East Chaves Planning Unit of the Roswell Resource Area of the Roswell District, Bureau of Land Management, U.S. Department of the Interior. Mathers Natural Area, a 362-acre tract, was so designated in August 1970. Part of the natural area was further designated a National Natural Landmark in May 1982. In September 1982 the 242 acres of national natural landmark were redesignated as Mathers RNA. The area is segregated from all forms of appropriation including mining and mineral leasing.

The 96-acre fenced area is managed for natural area and wildlife purposes; livestock and vehicles are excluded. The remaining acreage is unfenced. West of the fenced area an 86-acre tract is part of Allotment 5034 where, although grazing is permitted at an average density of 224 acres per cow year-round, actual use is light because of lack of water. Two smaller pieces of the RNA in other allotments are similarly managed. Prairie chicken, pronghorn antelope, and deer may be hunted in the whole research natural area.

Location and Access

Mathers Research Natural Area is in Chaves County, centered at lat. 33°28′40″ N., long. 103°49′30″ W., (fig. 42). in T. 10 S., R. 30 E., sec. 1 (NE1/4) and T. 10 S., R. 31 E., sec. 6 (W1/2 of NW1/4).

To reach Mathers from Roswell proceed 40 miles east on U.S. 380, thence from the roadside park 4.1 miles north on a graded road, where a cattle guard and east-west fence are just inside the natural area. The natural area is on both sides, 88% of it to the west, where a 96-acre fenced portion is adjacent to the county road. A bladed road (to a drilling pad) follows the north boundary of the natural area.

The nearest accommodations are in Tatum, 33 miles east of the roadside park, and in Roswell, 40 miles west. Campgrounds are in Bottomless Lakes State Park, off U.S. 380 southeast of Roswell.

Climate

Mathers is in a semi-arid, warm region, with mean temperature 59°F (15°C) and average precipitation 14 inches (356 mm.). The highest temperature recorded at

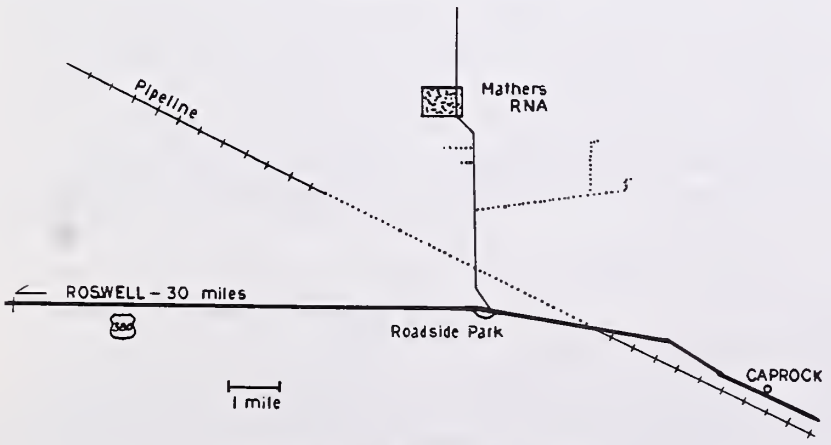

Figure 42. Mathers RNA.

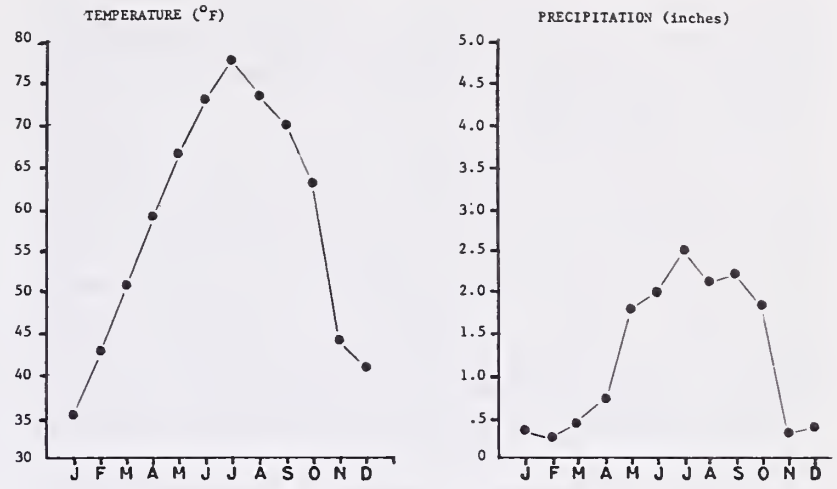

Figure 43. Climate of Mathers RNA.

Maljamar—42 miles south but similarly located in the Mescalero Sands—is 113°F (45°C), the lowest –10°F (–23°C). Climate is discussed by Davis (1979) and by Houghton (in Lenfesty 1983). Monthly data from Maljamar, about 150 feet lower than Mathers (Station Index No. 5370) are plotted in figure 43.

Physiography, Geology, Soils

Mathers Research Natural Area is in the Mescalero Sands, which are at the eastern edge of the Pecos Valley section of the Great Plains Province (Fenneman 1931). Mathers lies 5 miles west of 200-foot-high Mescalero Ridge (or Caprock), which is here the western edge of the Llano Estacado in the High Plains section.

In the research natural area elevation varies only from 4,135 to 4,160 feet (1,260–1,268 m.), but landforms are nonetheless of interest. They include hummocks and stabilized dunes, and sand blow-outs to 8 feet deep and 35 feet or more across.

These surface deposits are Pleistocene and Recent alluvium. Bedrock—not exposed—includes Permian rocks of Guadalupian age and, below them, other Permian, Pennsylvanian, and Devonian strata. Though reef rocks of the Guadalupe Series are major oil and gas producers, exploration in the immediate vicinity of Mathers RNA is reported to have yielded only dry holes. Producing fields are several miles north, east, and south.

Lenfesty (1983) maps Mathers RNA as Roswell Jalmar fine sands and discusses characteristics of the several soils included. Principal types are Ustipsamment soils—yellowish, fine sand (fig. 44) over thick deposits of sand with caliche at 20–40 inches—and Haplargid soils in which sand over-lies thick sandy clay loam with a caliche layer at 4 to 6 feet. The caliche layer, often exposed by shifting sand, is discussed by Bretz and Horberg (1949).

Vegetation

Shinnery (French *chênerie*, from *chêne*, oak) covers large areas of western Texas and Oklahoma, and in New Mexico occupies some 3,000 square miles or 2% of the state (fig. 44). Grazing practices that have led to increase in mesquite (*Prosopis*) and mineral extraction—oil, gas,

and phosphate—have left little of the shinnery intact. The Mathers area is relatively undisturbed (fig. 45). It might be argued that heavy grazing, aboriginally by bison, is a natural phenomenon.

Two-foot-high shinnery oak (*Quercus havardii*), sand sagebrush (*Artemisia filifolia*), and soapweed (*Yucca glauca*) are the only major shrubs. Diverse grasses, many of them rhizomatous, are in some instances two or three times as tall as the shrubs. Prominent are sand bluestem (*Andropogon hallii*, = *A. gerardii* var. *paucipilus*), little bluestem (*A. scoparium*, = *Schizachyrium scoparium* var. *neomexicanum*), giant dropseed (*Sporobolus giganteus*) and other dropseeds, fall witchgrass (*Leptoloma cognata*), gramas (*Bouteloua gracilis, B. eriopoda, B. curtipendula, B. hirsuta*), and three-awns (*Aristida longiseta* and *A. roemeriana*) (fig. 46). Forbs are also many, including several near their western limits. *Euphorbia geyeri, Phyllanthus abnormis, Stillingia sylvatica*, and *Asclepias arenaria* are among species limited to loose, sandy soils.

Davis et al. (1979) map the southeast edge of the RNA, outside the fence, as bearing shinnery subtypes that lack the abundant bluestem grasses of the remainder of the research area.

Shinnery oak has been represented continuously in the pollen profile of the Mescalero Sands for more than 3,000 years (Beckett 1976). Vegetation and flora of the Sands are described by Spellenberg (1979), Potter (1975), Davis et al. (1979), and Smith (1971).

Figure 44. Shinnery oak holding a sand ridge. Mathers RNA. (Courtesy of J. C. Egbert.)

Figure 45. Shinnery between fenced area and county road. Mathers RNA. (From Potter 1975, courtesy of L. D. Potter.)

Figure 46. Shinnery oak and dropseed on well-anchored ridge. Mathers RNA. (From Potter 1975, courtesy of L. D. Potter.)

Küchler (1975), surprisingly, maps the vast acreage of southeastern New Mexican shinnery as potentially producing Grama-Buffalo Grass (his Type 65). His Type 71 (Shinnery) seems more appropriate, and Donart et al. (1978) include the Mescalero Sands in their Type Plb, Mixed Bluestem-Shinnery.

Animals

The shinnery is a highly productive ecosystem for a semi-arid region, and animals in considerable numbers and diversity inhabit the Mescalero Sands. Aside from domestic cattle the principal herbivorous mammals are mule deer, pronghorn antelope, blacktail jackrabbit, and a variety of rodents for which, however, there are no site-specific records. Elsewhere in the Sands and probably at Mathers are ground squirrels (*Citellus spilosoma*), kangaroo rats (*Dipodomys spectabilis* and *D. ordii*), pocket mouse (*Perognathys* sp.), woodrat (*Neotoma micropus*), harvest mouse (*Reithrodontomys* sp.), white-footed mice (*Peromyscus* spp.), and pocket gopher (*Geomys bursarius*) (Davis et al. 1979, Smith 1971). Bison remains are still found; this species may have had major influence on present vegetation of the Mescalero Sands. Even more recently departed is a race of white-tailed deer believed by Smith (1971) to be distinct; a few survived around the RNA at least until 1967, but the lone survivor reported in 1980 was well south of Mathers RNA.

Carnivores in the vicinity include prominently coyote, bobcat, foxes (*Vulpes velox, V. macrotis*, and *Urocyon cinereoargenteus*), skunk (*Mephitis mephitis*), and badger (*Taxidea taxus*).

Common reptiles in the natural area are desert side-blotched lizard (*Uta stansburiana*), lesser earless lizard (*Holbrookia maculata*), and the six-lined race-runner (*Cnemidophorus sexlineatus*). The endemic sand dune lizard (*Sceloporus graciosus arenicolous*) occurs nearby but Egbert (1979) thinks that the natural area itself

provides only submarginal habitat. Several snakes are common including rattlesnakes (*Crotalus viridis, C. atrox,* and *Sistrurus catenatus*) and coachwhip (*Masticophis flagellum*).

Smith (1971) lists 70 bird species for the Mescalero Sands. Swainson's hawk, for instance, is a regular visitor to Mathers RNA, and several passerines nest in the shinnery. Of chief interest is the lesser prairie chicken, of which 3 nest sites were found by Davis et al. (1979) within the research natural area and 3 leks (booming grounds) near it. This species is restricted to scattered tracts of shinnery or sand sagebrush in the southern Plains states (Taylor and Guthery 1980). Although mainly insectivorous in summer, during other seasons prairie chickens depend heavily on acorns, catkins, and new leaves of shin oak (Davis et al. 1979). Nesting sites are related to abundance and height of grass; heavily grazed land is unfavorable (Davis et al. 1979).

Archaeology

The Mescalero Sands are rich in human artifacts that extend from 11,000 years ago (rare Clovis points) to recent use by Comanches and Apaches. Hunting of big game including mammoths and an extinct bison species attracted early visitors. In the Formative state (950–1450 A.D.) the large acorns of shin oak were a major attraction (Beckett 1975).

Intrusions and Threats

The graded road sustains moderate traffic, mostly petroleum-related, through the east side of Mathers Research Natural Area. Two short fences in addition to that protecting 96 acres of the area are near the south edge of the RNA. A watering device for small wildlife is in the northeast part of the fenced area. Drilling pads and other oil and gas development are near the natural area. Man—usually as a hunter of prairie chickens—and cattle visit this easily accessible area.

Research

Bureau of Land Management personnel collected baseline data on vegetation of the area in 1968. Considerable research has been done on prairie chickens and white-tailed deer of the Mescalero Sands (for instance Davis et al. 1979 and Smith 1971), but none seems to relate to Mathers RNA specifically. To map the RNA onto Davis' figure 11, draw a rectangle such that Nest Site 39 falls just north of the northwest corner and Lek 22 just east of the southeast corner.

Maps

Topographic: U.S. Geological Survey 1:24,000 series Mescalero Point NE Quadrangle. A variety of maps relating to soils, vegetation, grazing allotments, and range improvements is included in USDI BLM (1979b), and see further administrative maps at the Roswell office of the Bureau. Soil and aerial photography: Lenfesty (1983).

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MAXWELL RESEARCH NATURAL AREA

This seldom-dry playa lake on the plains of the upper Canadian River provides Canada goose and other waterfowl habitat. Alkali sacaton and small areas of wheatgrass-bluegrama-buffalo grass surround the lake.

Administration

Refuge Manager
Maxwell National Wildlife Refuge
P.O. Box 276
Maxwell, NM 87728 (505) 375–2331

The 3,270-acre Refuge was established in 1966; a unit of the National Wildlife Refuge System, it is administered by the Fish and Wildlife Service of the U.S. Department of the Interior. The former croplands were purchased in 1965 to restore Canada goose and duck habitat. A brief summary of the complex history of the Maxwell area is given by Lessard (1976). The 80-acre (32-hectare) RNA was designated August 17, 1973. The 235 acres immediately east of the RNA (but not, strangely, the RNA itself) have been recommended as a national natural landmark (Potter 1975).

The RNA is open to hiking but closed to all hunting. It is closed to livestock grazing, and has probably not been grazed since 1965. The west boundary is "indented" at one point to make room for a neighbor's dirt stock tank, but the fence is good here and on the south boundary. An old fence with breaks in it is along the east side of the RNA, and swings east of the boundary to include the southeast end of the lake, an extra acre or so.

Location and Access

Maxwell Research Natural Area is in Colfax County, centered at lat. 36°33′15″ N., long. 104°36′10″ W., (fig. 47). These 80 acres are in T. 27 N., R. 22 E., sec. 21 (W1/2 of the SE1/4), in the southwest corner of Maxwell National Wildlife Refuge.

To reach the natural area leave Interstate 25 at Maxwell, take the main street (Old U.S. 85) north 0.8 miles, turn west on N.M. 505, and from that point proceed 3.25 miles west, where the RNA is immediately north of the highway right-of-way. The Refuge entrance is 2.5 miles from that same turn, then north 1.25 miles to headquarters.

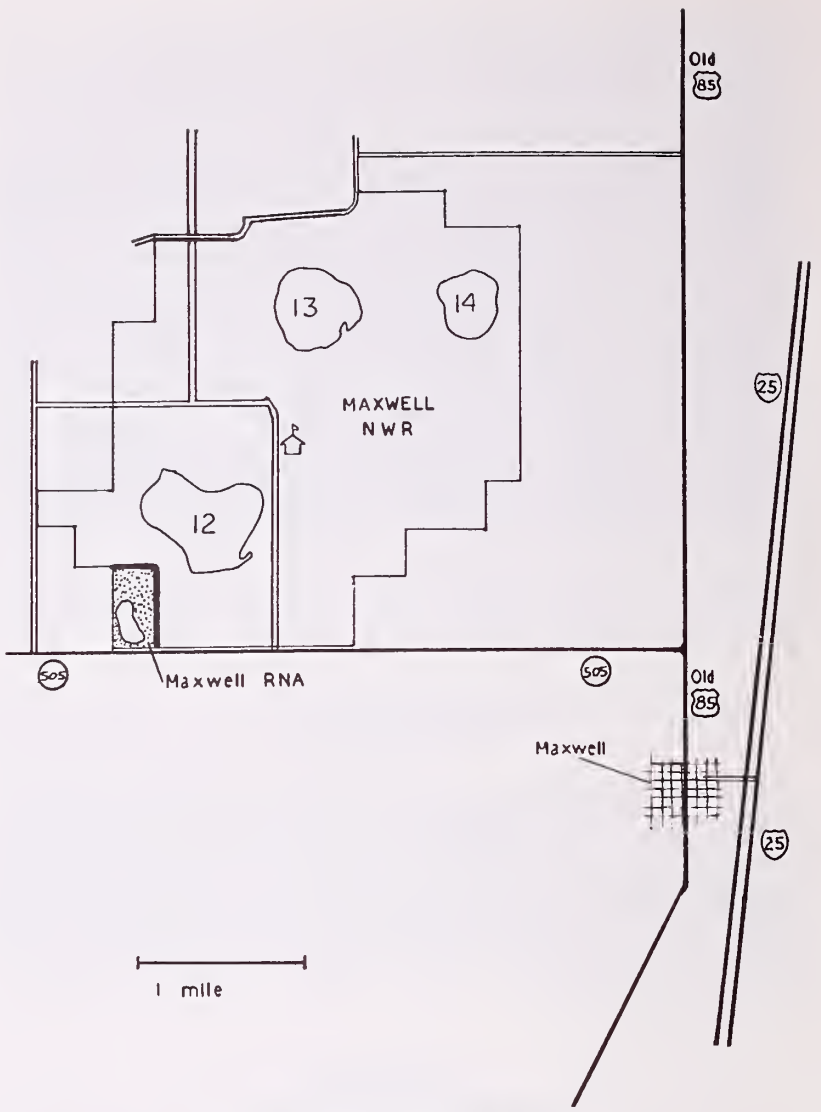

Figure 47. Maxwell RNA.

Nearest motels are in Springer, 17 miles south, and Raton, 26 miles north. There is no camping in the Refuge and no public land nearby.

Climate

This is a cool area with a ustic moisture regime. The mean temperature is 44°F (7°C) and the average precipitation 15.6 inches (396 mm.) per year. The record temperatures at Maxwell are 100°F (38°C) and –29°F (–36°C). Climate is discussed by Houghton (in Anderson et al. 1982) and by Griggs (1948), who gives data from the Maxwell weather station through 1940. Monthly averages from Springer, 14 miles to the south are graphed in figure 48.

Physiography, Geology, Soils

Maxwell is on the Las Vegas Plateau in the Raton section of the Great Plains Province. This part of the Las Vegas Plateau is no plateau, but rather the broad valley of the Canadian River and its tributary the Vermejo

River, which are 3.8 miles east and 2.6 miles south of the RNA, respectively. The land is flat, with mesas (plateau remnants) visible a few miles away especially to the northwest, where the higher Park Plateau meets the Las Vegas Plateau. The Sangre de Cristo Mountains are visible 25 miles to the west. Elevation in the RNA is from about 5,995 (1,827 m.) to 6,012 feet (1,832 m.).

A shallow lake—a playa lake typical of the area—occupies up to 25 acres or more of the natural area, varying in size seasonally and from year to year. Unlike other lakes on the Refuge, this is wholly a natural depression. Since 1966 it has been dry once, 1977, and completely full twice, 1968 and 1974. In late 1982 it covered perhaps 18–20 acres. Water—perhaps merely shallow run-off of irrigation water from nearby fields and canals—seeps in from the west side.

The northeastern 15 acres of the natural area are not part of the lake depression but a plateau raised a few feet above it. An irrigation ditch runs near the edge of the plateau.

Soil of the raised corner of the RNA is Swastika silty loam, with topsoil more than 4 inches deep and a 26-inch subsoil of silty clay. This is a mixed, mesic, aridic Argiustoll. Next south from this plateau, and also in the southwestern corner of the area, is Vermejo silty clay loam, characterized by a thin silty clay topsoil, a 16-inch silty clay subsoil, and a substratum containing salt crystals. It is a fine, mixed, mesic, ustic Torriorthent. The playa, mapped to include about 50 acres, contains an eroded combination of Swastika and Vermejo soils without their topsoils (Anderson et al. 1982).

Underlying strata are Upper Cretaceous: the Smoky Hill Marl member of the Niobrara Formation and the Pierre Shale, undifferentiated (Griggs 1948). No bedrock is exposed in the research natural area.

Vegetation

The upland 15 acres of Swastika loam have the Grama-Buffalo Grass Association (Küchler's Type 65) listed for the RNA (fig. 49). Western wheatgrass (*Agropyron smithii*), galleta (*Hilaria jamesii*), ring muhly (*Muhlenbergia torreyi*), wildrye (*Elymus canadensis*) and sand

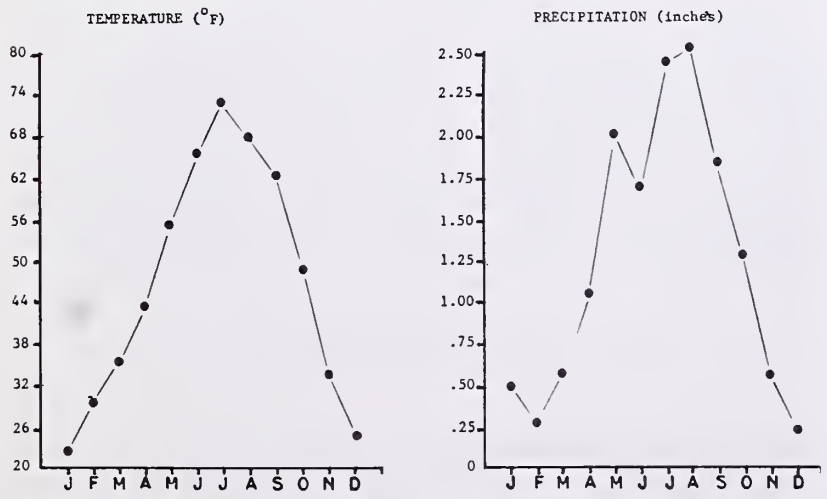

Figure 48. Climate of Maxwell RNA.

Figure 49. Buffalo grass and gramas in foreground; rabbitbrush in mid-ground; saltcedars by lake. Maxwell RNA.

dropseed (*Sporobolus cryptandrus*) as well as the named dominants (*Bouteloua gracilis* and *Buchloe dactyloides*) are present.

On disturbed earth next to the irrigation canal are several annual, non-native weeds. On the "breaks"—the slight declivity—are rabbitbrush (*Chrysothamnus nauseosus* var. *graveolens*), soapweed (*Yucca glauca*), and some of the grasses just mentioned.

Most of the natural area is covered by alkali sacaton (*Sporobolus airoides*) with some saltgrass (*Distlichis spicata*) and chenopodiaceous forbs between the sacaton hummocks (fig. 50). The west, wettest side of the pond has mainly sacaton but with a thicket of other grasses (prominently scratchgrass, *Muhlenbergia asperifolia*) and forbs such as *Conyza*. Toward the southwest corner some species listed above for the upland appear again.

The dry, crusty playa edge supports seepweed (*Suaeda*) and other fleshy-leaved forbs. One large and several small saltcedars were growing at the north end of the pond in 1982. The pond supports a mat formed by an unidentified filamentous alga.

Potter (1975) lists plants for an area adjacent to the RNA, many of them also in the natural area.

Animals

Several thousand Canada geese winter at the Maxwell Refuge. About 15 species of ducks use the Refuge, and 5 of them—mallard, gadwall, pintail, green-winged teal, and blue-winged teal—are recorded as breeding here commonly, while geese and cinnamon teal do so occasionally (USDI—Fish and Wildlife Serv. 1972) (fig. 51). Marsh hawk, kestrel, scaled quail, ring-necked pheasant, killdeer, avocet, mourning dove, roadrunner, barn owl, great horned owl, burrowing owl, nighthawk, rufous hummingbird, flicker, red-headed woodpecker, and 25 songbird species were also listed as nesting at the Refuge, of a total list (written after 5 seasons of Refuge operation) of 153 bird species. Sandhill crane, snowy egret, great blue heron, black-crowned night heron, white-faced ibis, white pelican, and double-crested cormorant are seen at various times of year. Golden eagles nest regularly nearby, on the Vermejo River, and bald eagle

sightings—now mainly restricted to fall and winter in New Mexico—here continue occasionally through summer. Presumably all these bird species use the natural lake in Maxwell RNA as well as the Refuge's larger impoundments, which have fishermen and picnickers.

Coyote, bobcat, raccoon, striped skunk, cottontail, jackrabbit, various bats, *Perognathus* and *Peromyscus* species, and a variety of other rodents are here.

Intrusions and Threats

An irrigation ditch and disturbed ground next to it, including a 2-track road, cross the northern part of the RNA. A lightly traveled state highway, with utility lines along it, is immediately south of the natural area, and a stock tank and cultivated fields are to the west. Planted trees that surrounded a farmhouse (now gone) are just outside the northwest corner of the RNA.

An 1,825-foot-deep test well to the Dakota Sandstone 3 miles west of the RNA produced no oil or gas.

Research

None is known.

Figure 50. Alkali sacaton. Trees are just outside the northwest corner of Maxwell RNA.

Figure 51. The lake, with ducks and algae. Maxwell RNA.

Maps

General: management maps are at Refuge headquarters and in USDI—Fish and Wildlife Serv. (1968) and in Potter (1975). Topographic: USDI—Geological Survey 1:24,000 series, Maxwell Quadrangle, 1971, and 1:100,000 series, Raton sheet, 1981. Geology: Griggs (1948). Soils: Anderson et al. (1982) and Potter (1975). Aerial photography: Anderson et al. (1982).

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MONUMENT CANYON RESEARCH NATURAL AREA

Ponderosa pine with scattered southwestern white pine covers most of these 640 acres in the volcanic Jemez Mountains. Some white fir and Douglas-fir occur in groups, and the latter species dominates the steep north-facing escarpment in the area's northwest corner. Bandelier Tuff is exposed in the walls of small canyons and forms sharp 60-foot spires and columns in the northwest.

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A "Cooperative Agreement Between the Department of Agriculture and the University of New Mexico for the Purpose of Research and Observation in Certain Natural Sciences" was signed in May 1930 by the President of the University and the Secretary of Agriculture covering 18 sections (11,520 acres) including the present RNA. In October 1932 the Regional Forester and the experiment station Director further designated one of the 18 sections—T. 18 N., R. 3E., sec. 9—as Monument Canyon Natural Area, and specified that neither live nor dead timber should be cut there. "No occupancy of any kind should be permitted. Conservative grazing may continue, but overgrazing must be avoided" on the 640 acres (259 hectares). Management of Section 9 as a natural area has been confirmed from time to time, most recently in the draft Santa Fe National Forest Plan. Timber cutting and other alterations on the other 17 sections covered by the cooperative agreement were to be restricted to such as the Chief Forester might permit, to contribute to study uses of the natural area.

In 1932 the allotment permitted 8 cows year-long on the 640 acres, which would be 32 cows for a 3-month season. It is not likely that grazing that heavy is occurring. In late 1982 no signs of recent livestock use were seen.

Mineral entry has not been prohibited, but mineral values are unlikely here. Hunting is permitted. There are no fences except at the head of a trail down the escarpment. The whole section is well posted as a research natural area (the only one in New Mexico so marked), but firewood cutting is the only activity explicitly prohibited on signs. Off-road vehicle maps show that the area is closed.

A goal expressed for the natural area (USDA—Forest Service 1982), "Maximum tolerable loss from wildfire objective is 10 acres," is probably unobtainable, should a fire start. See under "Intrusions and Threats," below. Because of easy access and abundant fuelwood the area is difficult to administer as a natural area.

Location and Access

Monument Canyon Research Natural Area is in northern Sandoval County, centered at lat. 35°48′20″ N., long. 106°37′30″ W., (fig. 52). It is sec. 9 of T. 18 N., R. 3 E.

To reach Monument Canyon from Los Alamos go south and west on N.M. 4 for 21 miles, then south on Forest Road 10 (a sign to Ponderosa is at the junction) for 2.4 miles, then west on Forest Road 135. The RNA is well signed beginning 1.2 miles from the latter turnoff. Road 135 wanders for 1.8 miles through the natural area.

The RNA may also be reached from the south: turn north from N.M. 44 on N.M. 4 at San Ysidro. The shorter but rougher route turns east on N.M. 290, 6 miles from San Ysidro; go through Ponderosa where the main road

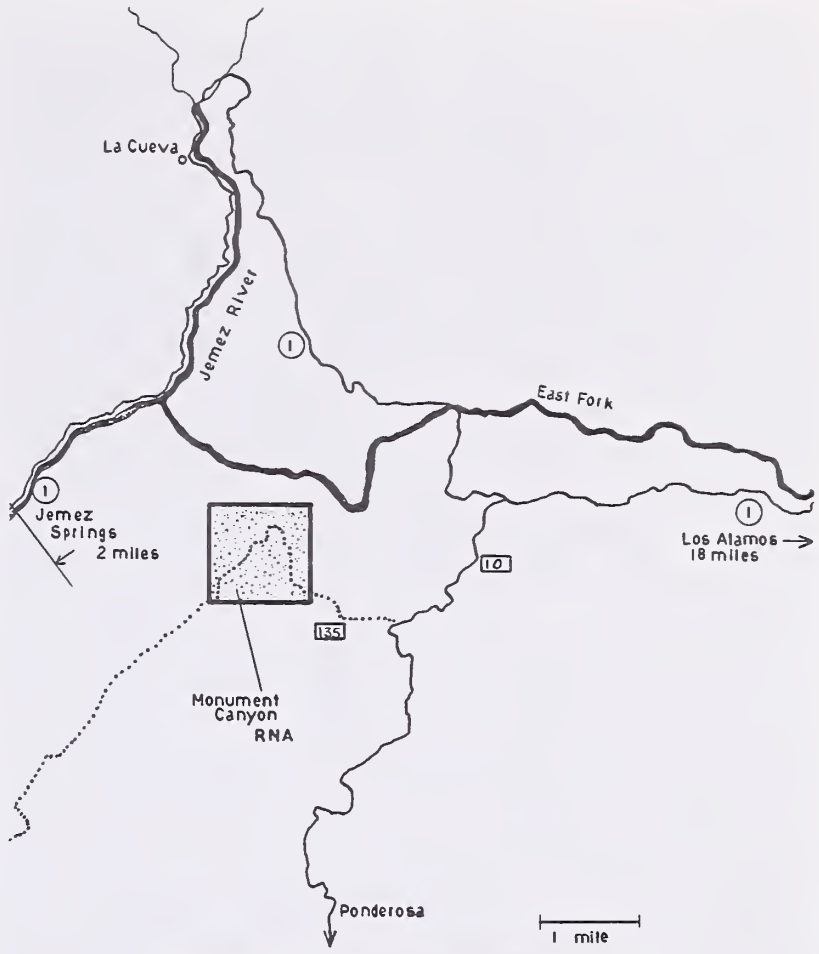

Figure 52. Monument Canyon RNA.

continuing is Forest Road 10; be careful to stay on Road 10 through junctions at Paliza Campground, and from there go about 8 more miles to the turn west on Forest Road 135. Smoother but longer is to stay on N.M. 4 from San Ysidro to its northern junction with Forest Road 10, 7 or 8 miles after La Cueva, as described above.

There are campgrounds at Paliza and La Cueva and at Las Conchas, 4 miles east of the northern Forest Road 10 turn-off; and camping is generally permitted throughout the national forest. There are motels in Los Alamos.

Climate

At 8,200 feet elevation, the area is quite cool and moist. The nearest weather station, at Jemez Springs, is only 3.5 miles southwest but is 2,000 feet lower than the RNA. From the mean temperature of 50°F (10°C) in Jemez Springs should be subtracted about 10°F (5°C), and to the average annual precipitation there of 16.4 inches (417 mm.) should be added about 7 inches (178 mm.) to represent the RNA (Tuan et al. 1973). The maximum rainfall expected within a 24-hour period, once in 2 years, is 1.7 inches.

Discussion or data relevant to the area are given by Griggs (1964) and Maker et al. (1971). Monthly distributions of average temperature and precipitation at Jemez Springs (Station 4369) are graphed in figure 53.

Physiography, Geology, Soils

The young, volcanic Jemez Mountains are a southern extension of the San Juan Mountains of Colorado-New

Mexico, and thus for most authors belong to the Southern Rocky Mountain Province. Fenneman (1931), though doubtful, agreed; Griggs (1964) puts the border between Southern Rocky Mountain and Basin and Range Provinces through Monument Canyon RNA.

The Jemez Mountains rise to 11,560 feet; Redondo Peak at 11,254 feet is 5 miles northeast of the natural area. Redondo Peak is a volcanic core within Valles Caldera, a 15-mile-diameter collapsed volcanic dome. The caldera held a lake in late Pleistocene time. When lake waters escaped to the southwest, probably by overtopping and cutting the lip of the caldera, they sliced deep canyons. The deepest, a mile west of the RNA, is Cañon de San Diego, 2 miles wide and 1,500 feet deep. Monument Canyon (canyon of the East Fork of the Jemez River) is about 1,200 feet deep at the north edge of the natural area; it joins Cañon de San Diego a mile to the northwest.

Except for about 120 acres of north-facing escarpment, the natural area is on the slightly dissected Jemez Plateau. The height-of-land runs very close to the escarpment at 8,310 to 8,536 feet (2,533 to 2,602 m.) elevation. From that divide 80% of the RNA drains southwestward through ephemeral streams, Church Creek and Cañon de la Cañada, to the Jemez River, with a low point of 8,145 feet (2,483 m.) where the Cañada leaves the southwest corner of the RNA. The much steeper northern escarpment drops with a slope of 50–60% from the ridge at 8,536 feet to the area's lowest point at 7,720 feet (2,353 m.) in the northeast corner. This declivity continues northward from the RNA to the East Fork of the Jemez at 7,250 feet elevation.

The natural area is fairly flat except near streams; these have cut several 50-foot-deep canyons, and a 200-foot wall stands beside the Cañada where it leaves the RNA.

There is no permanent water in the natural area.

The Jemez volcanic field straddles the western margin of the Rio Grande rift and consists of a thick pile of Pliocene and Quaternary extrusive rocks: the present elevation of the Jemez Mountains is due to this accumulation of volcanic rocks rather than to structural uplift (Griggs 1964, Woodward and Ingersoll 1979). Finally in mid-Pleistocene time volcanism was climaxed by two gigantic outbursts which produced the Bandelier Tuff (Smith and Bailey 1968), of which the Otowi Member covers most of the RNA (fig. 54). In eastern parts of the

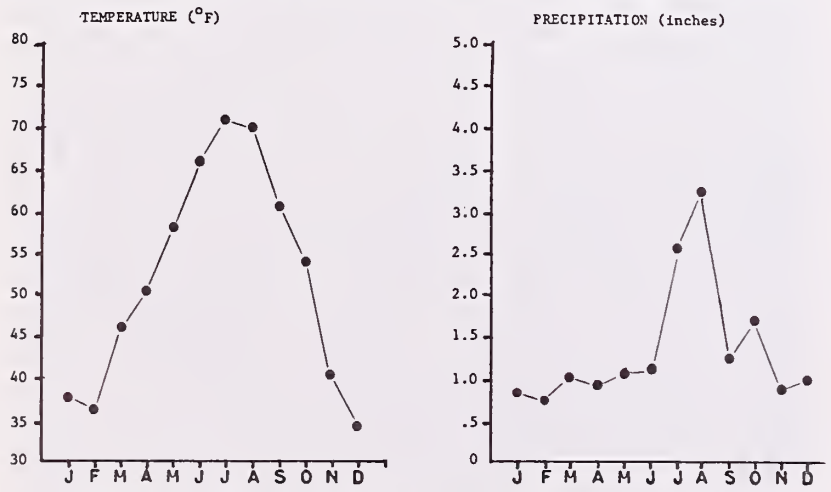

Figure 53. Climate of Monument Canyon RNA.

Figure 54. Ponderosa pine and a tuff boulder. Monument Canyon RNA.

RNA some of the El Cajete Member of the late Pleistocene Valles Rhyolite is mapped by Smith et al. (1970). Griggs (1964) describes these formations. In the RNA Otowi rocks crop out along stream canyons and at the lip of the northern cliffs. Handsome 60-foot-high sharp spines and boulder-topped columns are found in the north-draining canyon at the northern point on Forest Road 135.

Soils are classified by Maker et al. (1971) as Haploborolls and fine-loamy, typic Eutroboralfs. These authors describe several "mountain soils forming in igneous materials" without assigning them to associations. A more detailed soil survey is scheduled for publication by USDA—Soil Conservation Service.

Vegetation

Descriptions of the natural area in Forest Service documents list vegetation types as 590 acres of Interior Ponderosa Pine (Type 237), 36 acres of Interior Douglas-Fir (Type 20), and 14 acres brush; or, alternatively, 570 acres of commercial sawtimber and 70 acres "inaccessible." In 1943 volume was estimated at 85,000 board feet per acre. At some time average age, height, and diameter of both ponderosa pine and Douglas-fir were given as 125 years, 65 feet, and 22 inches. It is not clear what sort of averages these were. Dominant ponderosa pines in overmature stands are now 20–30 inches in diameter, but because there are hundreds of thousands of 2–4-inch-diameter trees in stagnated stands the average for all

pines (pole height or greater) would still be much less than 22 inches.

At any rate Interior Ponderosa Pine does cover more than 80% of the natural area. A few stands are thrifty but most are either overmature or stagnated with 8,000 stems or more per acre. Dwarf mistletoe (*Arceuthobium vaginatum*) infection stunts growth of pine in some areas, and Douglas-fir is also infected by its dwarf mistletoe parasite. The fuel load is enormous, composed of litter and dead trees both down and standing (fig. 55).

Two associates of ponderosa pine here are southwestern white pines scattered singly throughout and clumps of mixed conifers (mainly white fir and Douglas-fir), usually by streams or on north slopes. Rocky Mountain junipers occur on rocky sites, and canyon slopes also have ocean spray (*Holodiscus*), mountain mahogany (*Cercocarpus*), locust (*Robinia*), Apache plume (*Fallugia*), wax currant (*Ribes*), mockorange (*Philadelphus*), and, by far the most prominent, Gambel oak (*Quercus gambelii*). Upland grasses include Arizona fescue (*Festuca arizonica*), mountain muhly (*Muhlenbergia montana*), pine dropseed (*Blepharoneuron tricholepis*), and squirreltail (*Sitanion hystrix* = *Elymus longifolius*), but grasses are abundant only in occasional forest openings.

On about 120 acres of the escarpment is a mixed conifer stand of the species listed for Type 210 in the Southwest (Eyre 1980) (fig. 56): Douglas-fir with white fir a prominent associate, plus southwestern white pine, ponderosa pine, aspen, and Gambel oak.

Deichmann (1980) surveyed vegetation of the RNA and reported 43 plant species, which he grouped in 5 communities: *Pinus ponderosa* dense dog-hair stands, *Pinus ponderosa* open mature stands, *Pinus ponderosa*-mixed conifer associations, *Quercus* associations, and *Cercocarpus* associations. The latter 2 types have important grass components: mountain muhly and sheep fescue (*Festuca ovina*) with the *Quercus* associations and mountain muhly and blue grama (*Bouteloua gracilis*) with *Cercocarpus*. Good photographs of vegetation are provided by Deichmann (1980) and McCallum (1980).

Animals

Mammals have not been studied in the RNA. Bear and deer sign are occasional in draws and common on the escarpment. Tassel-eared squirrels are frequently seen. Presumably the fauna typical of southwestern ponderosa pine forests is present. Studies of mammals northeast of Monument Canyon are reported by Swickard et al. (1971), and eastward in Bandelier National Monument by Guthrie and Large (1980).

Figure 55. Ponderosa pine fuel. Monument Canyon RNA.

Figure 56. The northwestern escarpment. Ponderosa pine and Douglas fir. Rock pedestals. Canon de San Diego in background.

Bird ecology in the RNA has been studied in some detail by McCallum (1980), who sighted 47 species and gives a longer hypothetical list. Prominent in the RNA are band-tailed pigeon, flammulated owl, saw-whet owl, common nighthawk, white-throated swift, broad-tailed hummingbird, 5 woodpecker species, 5 flycatcher species, violet-green swallow, 4 corvid species, nuthatches, brown creeper, 3 warblers (especially Grace's warbler), and 4 fringillids (especially gray-headed junco). In 1982 turkey sign was occasional in the RNA.

The Jemez Mountain salamander (*Plethodon neomexicanus*) may be in the natural area on the escarpment. It is known 4 miles east and also 4 miles north, and habitat here seems suitable. The salamander is narrowly endemic: its total known distribution extends only about 18 miles east-west. New Mexico lists the species as threatened. For salamander biology see Stebbins and Riemer (1950), Reagan (1972), and Hubbard et al. (1979).

Intrusions and Threats

The Forest Service has from time to time reconsidered the suitability of Monument Canyon as an RNA because, being so accessible, it is difficult to protect. Firewood cutting in the area has been notorious; see, for instance, the Albuquerque Journal for 23 August 1974 on cutting in the RNA.

At least 5 roads are in the RNA. (1) Forest Road 135, while graded only occasionally, is passable for passenger cars. It leads to firewood areas and former timber-harvest areas west of the RNA. In its 1.8-mile passage through the RNA from the east it swings north close to the most scenic vistas, then southwest along the west rim of Cañon de la Cañada. (2) A road, formerly graded, connecting with Forest Road 135 near its northern curve and running the length of the bottom of Cañon de la Cañada. An attempt has been made to block it with earth at both ends, but this has not been completely effective. The road is revegetating slowly. (3) A short spur from the northern tip of Road 135 leading to a scenic overlook. Nothing on the ground indicates that this 2-track road is off limits. (4) A pack trail that once crossed the RNA a little south of the escarpment and, starting near the head of Cañon de la Cañada, descended the escarpment to the northeast. This was the Jemez Springs-Vallecitos de los Indios trail. The only part still conspicuous is the constructed section that runs from Forest Road 135 down the escarpment. Its entrance is fenced and gated. (5) Short logging spur roads, especially one in the west center of the RNA that branches from Forest Road 135. These are revegetating.

Cattle grazing seems to be a very minor intrusion. Grass composition and condition were excellent in 1982, given that this is a forest area without much grass.

The general area is rich in geothermal resources, but topography suggests that the RNA is not subject to development.

The principal threat appears to be fire. This has been recognized for decades by the Forest Service, and currently so in the Santa Fe Forest Plan. The situation is unnatural, resulting from control of normal wildfires that would have reduced fuel load. A fire during dry conditions could quickly destroy all the ponderosa pine here. Relevant research from a nearby area is reported by Foxx and Potter (1978).

Research

The Forest Service has sponsored botanical and ornithological studies of the RNA (Deichmann 1980, McCallum 1980).

Maps

General: USDA—Forest Service 0.5-inch-to-1-mile series, Santa Fe National Forest, 1975; and administrative maps. Topographic: USDI—Geological Survey 1:62,500 series, Jemez Springs Quadrangle, 1952,; 1:24,000 series, Jemez Springs Quadrangle, 1976, and Redondo Peak Quadrangle, 1977. Geology: Smith et al. (1970). Aerial photography can be inspected at Santa Fe or Jemez Springs; standard black-and-white print #106 can be ordered from the Aerial Photography Field Office, ASCS-USDA, Salt Lake City.

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RIO GRANDE MARSH RESEARCH NATURAL AREA

A narrow marsh and oxbow lake in the Rio Grande floodplain provide habitat for waterfowl and shorebirds and a feeding site for bald eagles and other raptors. Water levels are artificially managed. Tule marsh vegetation, abundant saltcedar, a few cottonwoods, and desert shrub occupy the 97-acre site.

Administration

Refuge Manager
Bosque del Apache National Wildlife Refuge
P.O. Box 1246
Socorro, NM 87801 (505) 835–1828

Rio Grande Marsh in one of 5 natural areas in the Bosque del Apache Refuge, a 57,191-acre unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1939. These 97 acres (39 hectares) were designated a research natural area August 17, 1973.

Access is allowed during daylight hours. Hunting is not allowed in the RNA. Fishing is allowed on the east side of the lake from late May through September. Grazing is not permitted, but there is evidence of trespass grazing between N.M. 1 and the marsh.

Another, larger part of the oxbow lake is just south of the RNA. Public access to it is forbidden. Hence this 50-acre area is better protected than the research natural area itself.

Location and Access

Rio Grande Marsh Research Natural Area is in Socorro County, centered near lat. 33°46′30″ N., long. 106°54′W., (fig. 57). It extends along N.M. 1 from 33°46′ to about

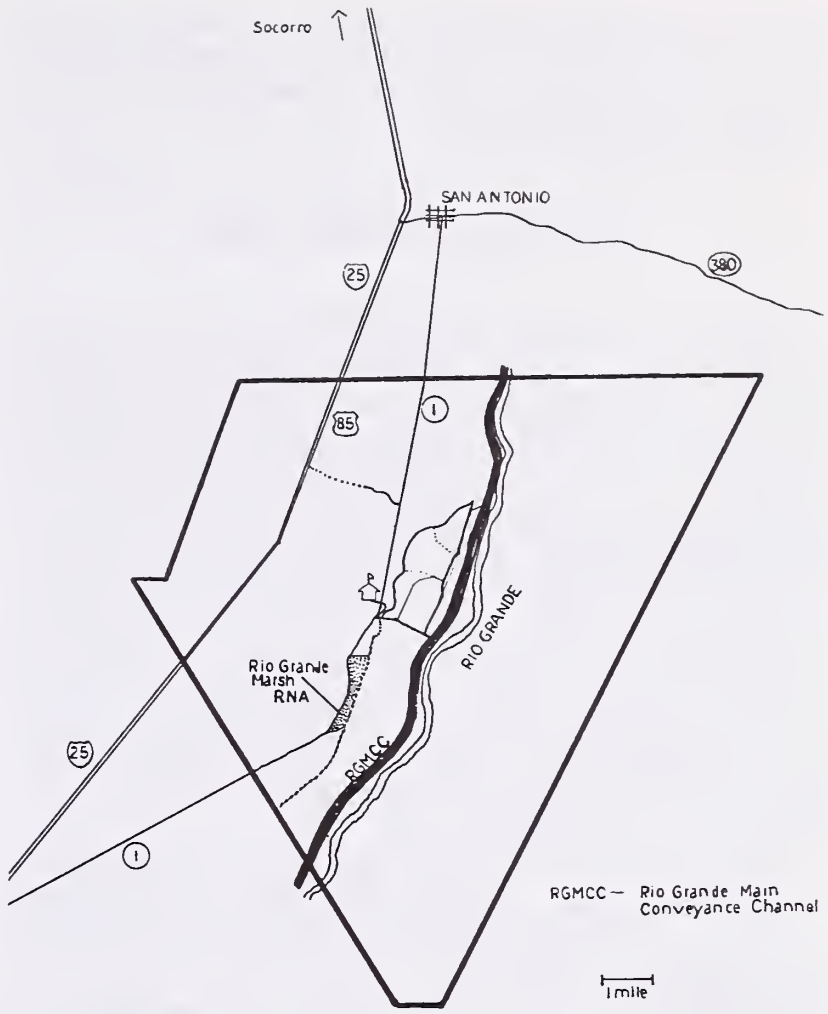

Figure 57. Rio Grande Marsh RNA.

lat. 33°47′22″ N. The north boundary is an east-west dike 0.4 miles long; it is the southern of two such neighboring dikes. The south boundary is a dike topped by a road that runs northeast from a point near N.M. 1, about 200 yards north of a railroad crossing. The east boundary is a graded Refuge road. Only the west boundary—N.M. 1—is fenced. Were the area surveyed it would be near the east edge of T. 6 S., R. 1 W.

Rio Grande Marsh is 19 miles south of Socorro and 132 miles north of Las Cruces. From the north turn off Interstate 25 for San Antonio; from the town of San Antonio follow Refuge signs 8 miles south on N.M. 1 to headquarters of Bosque del Apache Refuge; the RNA begins another 1.1 miles south of headquarters. From the south turn off for San Marcial and follow N.M. 1 northeast for 6.6 miles to the Refuge boundary and another 1.8 miles to the south edge of the RNA; Refuge headquarters are another 3 miles north. The west side of the RNA lies along N.M. 1. Access to the oxbow lake is easier, however, from the east side: enter the tour loop from headquarters and go south; continue straight where the main route turns left across a canal, and follow the road to its southern end at the RNA.

Accommodations are available in Socorro, 20 miles north.

Climate

Campbell and Dick-Peddie (1964), Houghton (p. 7–9 in Maker et al. 1972), and Poulsen and Fitzpatrick (1931)

discuss climate of the area. Data from Refuge headquarters, a mile north of Rio Grande Marsh and a few feet higher, are given in figure 7 under Apache Camp Research Natural Area.

Physiography, Geology, Soils

The area is within the Basin and Range Province, which the Rio Grande here traverses in a rift valley (Hawley 1978). The natural area is in the Rio Grande floodplain and has been subject over the centuries to floods and to changes in the river's course. The only detailed soil map available (Poulsen and Fitzpatrick 1931), from an early 1929 survey, was largely outdated in August 1929 by a devastating flood that buried or washed away nearby towns such as Val Verde, 3 miles downstream. In 1929 the Rio Grande reached the southeast corner of what is now Rio Grande Marsh RNA; the river is now 1.5 miles east. The locality of the natural area is shown as partly marsh and oxbow lake in 1929, alkaline but less so than nearby parts of the floodplain (Poulsen and Fitzpatrick 1931).

Elevation is just under 4,500 feet (1,371 m.) in wet parts of the RNA, rising to 4,520 feet (1,378 m.) along N.M. 1. Three usually dry washes enter under N.M. 1 from the highlands to the west.

Distribution of marsh versus lake is controlled artificially within a narrow range, with a goal of maintaining the present mix of wetland habitats. Aerial photographs in 1972 show the area wetter than the 1929 survey, about 20% water, 40% marsh, and 40% land. There may be more pond and less marsh than this under current management.

No bedrock is exposed in the natural area.

The Gila-Vinton-Glendale soil association (Maker et al. 1972) is probably represented here mainly by Gila soils, particularly Gila clay on the west side, and Gila loam. Riverwash and Alluvial Land are also present. Soils are classified as Torrifluvents, Calciothids, and Torriorthents.

Vegetation

The east side of the RNA comprises ponds and tule marshes, and the latter reach the west side in the narrow (900-foot) central part of the research natural area. Dominants are cattail (*Typha*) and bulrush (*Scirpus validus*) with areas of saltgrass (*Distichlis spicata*), fig. 58. Next to the water are willows (*Salix exigua*) and saltcedar (*Tamarix*) forming an almost unbroken border along the west side of the wet area.

Dry soils—some clay, some sand—in the northwest and southwest corners of the RNA support about 40 acres of desert shrubs, primarily broom pea (*Psorothamnus* or *Dalea scoparia*), four-wing saltbush (*Atriplex canescens*), shadscale (*A. confertifolia*), and mesquite (*Prosopis glandulosa*), with scattered juniper (*Juniperus monosperma*) and, nearer the water, cottonwood (*Populus wislizenii*).

Figure 58. Bulrushes, mud, lake, marsh. Rio Grande Marsh RNA.

Dropseeds including giant dropseed (*Sporobolus giganteus*) are conspicuous in sandy areas.

Animals

The Refuge in general and Rio Grande Marsh in particular were established to protect wetlands for birds; the effort has been abundantly successful. Nearly all of the 295 bird species known on the Refuge (USDI—Fish and Wildlife Service 1982) might be found in the RNA, which provides a variety of habitats and even in "off" seasons is alive with wings. Nesting by waterfowl, shorebirds, and songbirds begins in April-May with the young hatching in May-June. Migrants from the north arrive in September-November, including large numbers of mallards, pintails, shovelers, teal, gadwalls, and ruddy ducks, snow and Canada geese, and greater sandhill cranes. Crane and waterfowl populations are near their peaks from late November through January. A few whooping cranes, the result of transplants, winter on the Refuge.

Frogs and toads, tiger salamanders, lizards, and snakes are common. Mammals include bats (14 species recorded in the Refuge), coyote, bobcat, raccoon, striped skunk, black-tailed jackrabbit, and cottontail. Of the many rodent species present, *Zapus hudsonius luteus* has been trapped in the research natural area.

Intrusions and Threats

The research natural area is surrounded by traveled roads and dikes. Fishing is allowed on the east side; however, no native-fish values are known here. Because of control projects along the Rio Grande, the area is no longer subject to inundation; water will be pumped into the lake and marsh to maintain near-constant levels. Pumping is expected to prevent entrance of rough fish (carp and bullhead), and the ponds will be allowed to dry out from time to time to eliminate those fish that do enter. Periodic burning is authorized for vegetation control, with a burn scheduled for the spring of 1983 to

remove cattails. Non-native saltcedar has become a major component of the vegetation. Beehives are kept in the area, largely for saltcedar honey.

Research

Several University of New Mexico thesis studies in zoology have been done at the Refuge, and at least K. Peterson's on *Zapus* systematics (about 1980) involved Rio Grande Marsh. C. C. Reith studied bat activity, with results to be published in Southwestern Naturalist and Journal of Mammalogy. B. D. Woodward studied organization of anuran communities (1981).

Maps

Topographic: U.S. Geological Survey 1:24,000 series, Indian Well Wilderness Quadrangle, 1981. Soils: Poulsen and Fitzpatrick (1931), Maker et al. (1972). Geology: Bachman and Stotelmeyer (1967).

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SAN PASCUAL RESEARCH NATURAL AREA

Little San Pascual Mountain rises 700 feet above the west edge of the Jornada del Muerto on these varied 3,200 acres. Sedimentary and igneous rocks of Permian to Pleistocene ages are in evidence. Chihuahuan Desert grassland and shrubland, free and shrub-anchored dunes, and desert riparian vegetation form a mosaic. Pronghorn, mule deer, coyote, and golden eagle are among the many wildlife species.

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San Pascual is one of five natural areas in Bosque del Apache National Wildlife Refuge, administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established in 1939 on land purchased by the federal government in 1936 after many decades of grazing use. The approximately 3,200-acre (1,295-hectare) RNA was designated December 7, 1972. In 1975 the Congress made the area part of the 19,859-acre Little San Pascual Wilderness, from which vehicles are excluded.

The RNA is not posted as such, and is fenced only on the east side, which is the Refuge boundary. There is a locked gate across the roadway by the Little Black Mesas. The natural area is open in season for deer, quail, and rabbit hunting but not for pronghorn antelope. It has not been open to legal grazing for several years. Mineral entry, including prospecting, is prohibited.

Location and Access

San Pascual Research Natural Area is in Socorro County, centered at lat. 33°43′45″ N., long. 106°51′30″ W. (fig. 59). Were the area surveyed it would be in T. 6 S., R. 1 E., and, mostly, T. 7 S., R. 1 E. The east boundary is the Refuge boundary fence. The north boundary of the RNA is along the same roadway ("Pack Trail" of the 1982 topographic map) that is the south boundary of Jornada del Muerto Research Natural Area. The west boundary is 25 feet east of a pipeline that runs south-southwest from the sandstone buttes prominent on topographic maps. The south boundary is a problem: no remembered mapped features were used to delineate it, and we have been unable to obtain a definite location. Reputedly the boundary heads about west-northwest from a point near the north end of Section 17 next to the Refuge; thus Little San Pascual Mountain above 5,020 feet elevation would be in the RNA.

To reach the northeast corner of San Pascual RNA from Interstate 25, turn east on U.S. 380 10 miles south of Socorro. Starting from that exit pass San Antonio at 0.7 miles, the Rio Grande at 1.7, and turn south on Socorro County A153 at 7.4 miles; follow it past Fite Ranch at 9.3 to the Harriet Ranch junction at 20.3; thence continue west past a tank and well (Mike Well on 1982 map) at 22.7, where turn west-southwest off the bladed road on a sometimes-bumpy two-track and proceed to

the Refuge fence and the RNA at 25.7 miles from I-25. At least for 4-wheel drive there are several points of access to the east side of the RNA and a trail along the Refuge boundary; to find them use no map older than 1982 topographic quadrangle. It is also possible to reach San Pascual RNA from Engel, which is on N.M. 52 40 miles to the south; carry water, maps, and in late summer, chains.

To reach the west side of San Pascual RNA from Refuge headquarters, during daylight only, go to Apache Camp RNA as described under that name; leave it on the left and go straight across the Main Conveyance Channel; turn north for a few yards till a road goes east over the high dike; follow that road to the natural channel of the Rio Grande. In fall and winter the channel may be dry enough to drive across; usually it can be waded. Roads lead south from this crossing for about 4 miles to the northwest corner of San Pascual RNA, just south of the conspicuous sandstone buttes (Little Black Mesas). Do not drive into designated wilderness, of which the western boundary here coincides with that of the RNA.

Accommodations are available in Socorro.

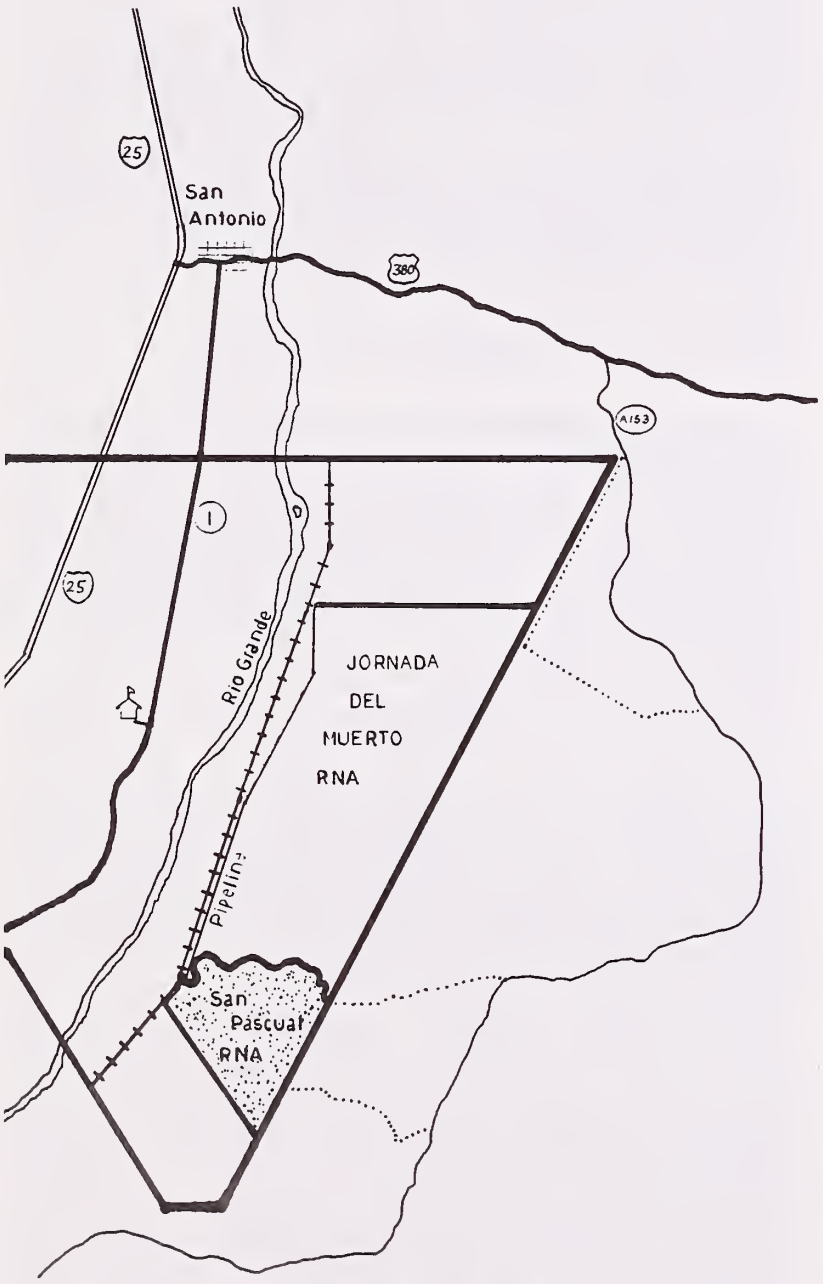

Figure 59. San Pascual RNA.

Climate

Climate is discussed by Houghton (in Maker et al., 1972): this is a warm, arid region with most of the 8 inches (200 mm.) of precipitation coming in late summer. Data from the weather station at Refuge headquarters, about 5.5 miles northwest, are in figure 7 under Apache Camp RNA, above.

Physiography, Geology, Soils

Little San Pascual Mountain, which occupies most of the RNA, is an isolated fault-block range typical of this Mexican Highland section of the Basin and Range Province (fig. 60). It rises 700 feet above the Jornada del Muerto Plain to the east (see Jornada del Muerto RNA in this report) and 1,000 feet above the floodplain of the Rio Grande, 1.5 miles west, to a height of 5,525 feet (1,684 m.). Lowest elevation in the RNA is 4,600 feet (1,402 m.) along the western edge, 0.6 miles west of the mountain front at 4,800 feet. That western part of the area comprises gentle ridges and sand-floored rocky washes, with one small group of free sand dunes. The mountain forms a divide between the Rio Grande drainage and the Jornada del Muerto closed basin.

Little San Pascual Mountain exposes Permian (Abo and Yeso Formations), Pennsylvanian, and Tertiary bedrock (Geddes 1963) (fig. 61). The Permian beds are a little outside the RNA to the south, as are the prospect pits and shaft that found a little copper in both Abo and Yeso Formations. Most of the mountain is gray to tan Pennsylvanian limestone, but also with arkosic sandstones and shales, partly silicified along the west margin of the mountain (Bachman and Stotelmeyer 1967). Identity of these Pennsylvanian rocks is discussed by Kottlowski (1960). Along the lower western slopes of the mountain are exposed, at the base, Paleocene andesite, and above it complexly bedded conglomerates, sandstones, and clay interbeds of the late Tertiary Santa Fe Group (in the wide sense). These are mostly poorly consolidated alluvium, but with some limy cement. The beds are mainly tan to yellowish gray; they dip gently west (Bachman and Stotelmeyer 1967).

Ascending from the valley bottom, the Rio Grande Entisol bottomland groups give way up the slope of the mountains to an Aridsol of Haplargids-Torripsamments construction. Except for the higher mountains the natural area is mapped for Berino-Bluepoint-Onite soils by Maker et al. (1972). This association is characteristic of the Jornada del Muerto in Socorro County. It includes several soil types, but mainly the three named, which have a thin surface layer of sandy loam or loamy sand over thick subsoils. These may be sandy clay loam (Berino), loamy sand or sand (Bluepoint), or sandy loam (Onite). Undulating or hummocky topography redominates in these deep soils in the RNA, with a few coppice dunes.

Maker et al. (1972) map Little San Pascual Mountain as bearing Rock Land-Lehmans-Lozier soils, characteristic of steep slopes with much exposed bedrock in Socorro County. These are thin soils with abundant loose

rock; Lozier soil is strongly calcareous with limestone bedrock usually at 6 to 15 inches in depth.

Vegetation

Impressive diversity marks the plant communities. Black grama (*Bouteloua eriopoda*) covers part of the northeastern "flats," but other parts and also ridges and slopes throughout the RNA have creosotebush (*Larrea divaricata*) either as sole species or with *Muhlenbergia porteri*, prickly pears (*Opuntia* spp.), fluffgrass (*Erioneuron pulchellum*), three-awns (*Aristida* species), snakeweed (*Gutierrezia sarothrae*), fetid marigold (*Dyssodia acerosa*), and other species that often indicate degraded rangeland. Broom pea (*Psorothamnus* or *Dalea scoparia*) with sand sagebrush (*Artemisia filifolia*) and dropseeds (*Sporobolus* spp.) dominate the deeper, sandier soils. Mesquite (*Prosopis glandulosa*) is in some parts of the sand community (fig. 62). A tangle of shrubs takes over rocky areas in washes: sumac (*Rhus microphylla*), saltbush (*Atriplex canescens*), Apache plume (*Fallugia paradoxa*), sagebrush (*Artemisia* spp.), and a *Salvia*, with side-oats grama (*Bouteloua curtipendula*) and other relatively mesic grasses. The sumac occurs also atop

Figure 60. Little San Pascual Mountain from the northwest.

Figure 61. Northwest from Little San Pascual Mountain. The mid-ground Little Black Mesas are just outside San Pascual RNA.

Figure 62. Sand sagebrush, dropseeds, a few mesquite bushes, and Little San Pascual Mountain and Center.

dunes, and occasional saltbushes are scattered in creosotebush and other communities. Higher on the mountain are junipers (*Juniperus monosperma*) with saltbush and a variety of grasses. Almost pure stands of oreja de perro (*Tiquilia canescens*) occur on a few gravelly slopes. This species occurs also in limestone communities dominated by ocotillo (*Fouquieria splendens*), with creosotebush and dropseeds. Sumac (*Rhus aromatica* var. *trilobata*) and greasebush (*Forsellesia spinescens*) grow on the summit in crevices.

Near the northern edge of the RNA a sandy wash in a shallow box canyon supports a riparian community dominated by desert willow (*Chilopsis linearis*).

Küchler (1975) maps potential natural vegetation for this part of the Jornada del Muerto as Grama-Tobosa Shrubsteppe (his Type 58). This does apply to the northeast corner of the RNA. Most of the area might potentially bear the Mixed Dropseeds—Indian Ricegrass association of Donart et al. (1978), but with emphasis on its shrub components.

Animals

Findley et al. (1975) list 20 mammals including 11 rodent species collected in the vicinity that could occur in such a dry area as San Pascual; the nearest water is 1.5 miles east (a trough) or west (Rio Grande). Mule deer, black-tailed jackrabbit, desert cottontail, and coyote sign are common in the RNA, and pronghorns doubtless use the area. Quail, mourning dove, roadrunner, red-tailed hawk, and golden eagle were sighted in the summer of 1982. Several snake and lizard species are common.

Intrusions and Threats

The north boundary road has been patrolled 2 or 3 times a year in recent years; no other vehicles are allowed. The west boundary is an incompletely buried pipeline accompanied by a faint two-track road and a few route markers. The east boundary—the Refuge fence—is accompanied on the outside by a jeep trail. A

road entered the southeast corner of the RNA at boundary marker 23 and led to a structure 400 yards within the area, but 1972 aerial photos do not show these old intrusions.

In general the area seems isolated and remarkably free of man's works except for rather large numbers of his cattle outside the eastern boundary fence.

Research

Only geological field work is known.

Maps

Topographic: USDI—Geological Survey 1:24,000 series, Little San Pascual Mountain Quadrangle, 1982; and the western-most 120 acres are on the San Marcial Quadrangle, 1982. Soils: Maker et al. (1972). Geology: Geddes (1963).

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VEGOSA RESEARCH NATURAL AREA

Grassland and juniper-oak savanna cover this gently sloping, 537-acre wildlife (and livestock) area. Potentially a fine example of plant and animal life of the Las Vegas Plateau, the land has not fully recovered from past overgrazing.

Administration

Refuge Manager
Las Vegas National Wildlife Refuge
P.O. Box 1070
Las Vegas, NM 87701 (505) 425–3581

The 9,450-acre Refuge is a unit of the National Wildlife Refuge System administered by the Fish and Wildlife Service, U.S. Department of the Interior. The Refuge was established on purchased land in 1966 to restore an area that had been an important wildfowl resting area in years past. The 537-acre (217-hectare) research natural area, designated August 17, 1973, contains no permanent water so is not directly involved with waterfowl.

Cattle are grazed in the RNA under permit to local ranchers. The northeast section of Vegosa was grazed in September of 1980 and in August of 1982, but rested in 1981. The southwest section was grazed for 5 weeks in September-October 1981 but rested in 1980 and 1982.

The RNA is not posted nor fenced as such, though along the south and east borders occasional signs mark the Refuge border and forbid unauthorized entry. A permit from the Refuge Manager is required to visit the RNA. Hunting is prohibited there.

Location and Access

Vegosa Research Natural Area is in San Miguel County at lat. 35°30′40″ N., long. 105°09′15″ W., (fig. 63). Part of the Las Vegas Grant, the area was not included in the United States land survey, but would be in T. 15 N., R. 17 E. The boundaries are irregular and defined mainly by topography: the RNA is in the southeast corner of the Las Vegas National Wildlife Refuge and includes the plateau within about 2,000 feet of the lip of Vegosa Canyon, with a western limit along long. 105°10′07″ W., and a northern limit along lat. 35°31′17″ N.

Las Vegas National Wildlife Refuge is 5 miles southeast of Las Vegas. From downtown Las Vegas or from the N.M. 65–104 exit of Interstate 25, drive east on N.M. 65–104 about 1.5 miles, turn south on N.M. 281 and follow its turns for 4.5 miles to Refuge headquarters,

where a permit to enter the RNA may be sought. Vegosa RNA is at the southeastern extremity of the Refuge, 3 miles south of headquarters or a mile southeast of McAllister Lake. Unless gates that are ordinarily locked are opened, the last 0.75 miles must be covered on foot.

Accommodations are in Las Vegas. Camping is permitted at McAllister Lake, in an area managed by the New Mexico Department of Game and Fish.

Climate

This is a cool, moist area with mean temperature 50°F (10°C) and average annual precipitation of 16 inches (400 mm.). Climate of the area is discussed by Griggs and Hendrickson (1951) and by Hilley et al. (1981). Monthly data at Las Vegas are given in figure 22 under Gallinas RNA, which is almost adjacent to Vegosa RNA.

Physiography, Geology, Soils

The Refuge is at the southwestern edge of the Las Vegas Plateau and the western edge of the Great Plains. This corner of the Plateau is in the Pecos River drainage.

Typical of the Plateau, Vegosa RNA is a peneplain deeply cut at its edge by a steep-sided river canyon. The long eastern border of the RNA is the lip of Arroyo Vegosa (Vegosa Creek Canyon), which joins the Gallinas River a few hundred yards south of the RNA. The canyon is 300 feet deep and averages about 1,200 feet wide at the top: the average slope of its sides is 45%. The creek (outside and below the RNA) is small but apparently permanent. The uppermost 12–20 feet of canyon walls are vertical cliffs, but there are occasional breaks that can be clambered over.

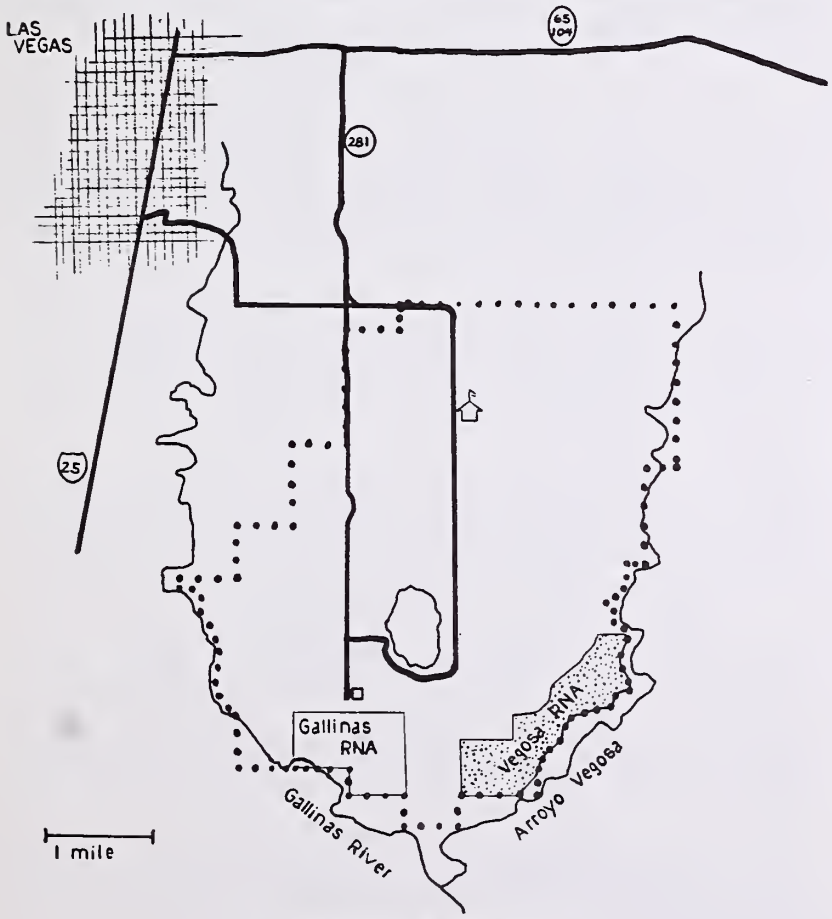

Figure 63. Vegosa RNA.

Except near its southwest corner, the RNA slopes gently away from the edge of the canyon, so that drainage is northwestward, mostly to McAllister Lake, which has no surface outlet. Except in the southwest corner the elevation drop is from 6,540 to 6,500 feet (1,993–1,981 m.) or less across the 0.4-mile-wide area. The southwest corner drains southward through a steep side canyon of the Vegosa, which leaves the RNA at 6,380 feet (1,945 m.) elevation. This side canyon is normally dry but, just as along the lip of the canyon, there are small, shallow pools in rocky basins after rains.

Bedrock is the Dakota Sandstone, of Late Cretaceous age, which serves as a caprock here and over much of the Las Vegas Plateau. It is exposed along the escarpment. Griggs and Hendrickson (1951) describe the formation as fine-grained, highly quartzitic sandstone, containing pebbles of quartz and of chalcedonic silica. Exposures in Vegosa RNA have all weathered to brown or reddish-brown. At Las Vegas the Dakota's thickness is 220 feet. Jacka and Brand (1972) and Lessard and Bejnar (1976) give further geologic data.

Soils are mollisols of the great group Argiustolls, except for the Tricon component, a Petrocalcic Paleustoll (Hilley et al. 1981). On a 500-foot-wide strip along the escarpment and in the western edge of the RNA is the shallow, well-drained Bernal loam, lying on sandstone less than 2 feet down. Most of the rest of the RNA comprises Partri-Carnero Association, a mix typically of 55% Partri silt loam and 30% Tricon silt loam, with small areas of Bernal and Carnero soils. This association is deep and well-drained. Four areas along the northwestern border have Carnero loam, also deep and well-drained.

Vegetation

This is grassland, but along the escarpment there is a strip (corresponding with the distribution of thin, Bernal soil) of open woodland composed of junipers (*Juniperus monosperma* and *J. scopulorum*), pinyon (*Pinus edulis*), and wavyleaf oak (*Quercus undulata*) (fig. 64). Down-slope (northwest) of the woodland are widely spaced one-seed junipers, mostly young, indicating invasion of the grassland. Parts of the edge of the canyon support a thin line of ponderosa pine, and young ponderosas, along with Rocky Mountain junipers, are prospering in the southwestern side canyon. Associated with the conifers are many grasses, among them *Muhlenbergia montana*, *Panicum bulbosum*, *Eragrostis intermedia*, *Agrostis scabra*, *Schizochyrium scoparium*, *Sorghastrum nutans*, *Lycurus phleoides*, *Andropogon gerardii*, and, commonest of all on the side-canyon rocks, *Blepharoneuron tricholepis* (fig. 65).

The open grassland is a patchy mixture of many species, but with a preponderance of species such as three-awns (*Aristida* spp.), squirreltail (*Sitanion hystrix*), hairy tridens (*Erioneuron pilosum*), blue grama (*Bouteloua gracilis*), ring muhly (*Muhlenbergia torreyi*),

and sage (*Artemisia carruthii*) that indicate past overgrazing. Better grass stands occur in parts of the juniper savanna, for instance extensive wolftail (*Lycurus phleoides*) and patches of needle-and-thread (*Stipa comata*) and of sideoats grama (*Bouteloua curtipendula*).

The grassland is a meeting place of southern, Rocky Mountain, and Great Plains species, for instance *Eragrostis curtipedicellata* at its western limit.

Northern spleenwort (*Asplenium septentrionale*) is common in crevices in the cliff at the top of the escarpment.

Although Vegosa RNA has been listed as potentially producing Grama-Buffalo Grass (Küchler's Type 65), that type seems here to be limited to Carnero soils, which are scarce in the RNA. Classification as Grama-Galleta Steppe (Küchler's Type 53) seems more realistic.

Animals

Mule deer, Nuttall's cottontail, coyote, and bobcat are common. A large number of rodent species seems probable, but no list for the Refuge is available. Other likely mammals are desert shrew, gray fox, raccoon, long-tailed weasel, mink, striped skunk, mountain lion, and black-tailed jackrabbit.

Figure 64. Oak-juniper savanna. Vegosa RNA.

Figure 65. Tall grasses, pinyon and ponderosa pine in a side canyon. Vegosa RNA.

Turkey, prairie falcon, and red-tailed hawk are conspicuous. Burrowing owl, long-billed curlew, scaled quail, roadrunner, golden eagle, and (in winter) bald eagle have been cited for the area. The Refuge bird list (USDI—Fish and Wildlife Serv. 1972) includes 131 species other than waterfowl, 54 of them known to nest in the Refuge.

Intrusions and Threats

A 2-track road through the RNA parallels the escarpment; it is still in use for Refuge vehicles. At the eastern end of the area the road goes out on a narrow "peninsula" to the canyon rim. Pre-Refuge domestic trash dumps, no longer conspicuous, are near the east and southwest extremities of the RNA. There are shallow caliche or gravel pits, with accompanying mounds, just inside and just outside the RNA's western border. The RNA, though not fenced on its perimeter, is cut by a fence (newer than RNA status?) that separates the northernmost third of the area from the rest.

Livestock grazing, discussed above under "Administration," is probably the major non-natural intrusion; it is intended to maintain the shortgrass community.

Research

None is known.

Maps

Topographic: U.S. Geological Survey 1:24,000 series, Las Vegas Quadrangle, 1963. "Arroyo Pagosa" of this map is called "Arroyo Vegosa" in the present report, it being thought locally that "Pagosa" was wrong. Geology: Griggs and Hendrickson (1951). Soils: Hilley et al. (1981). Aerial photography: Hilley et al. (1981).

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Peterson, Roger S.; Rasmussen, Eric. 1985. Research Natural Areas in New Mexico. USDA Forest Service General Technical Report RM–136, 58 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

New Mexico's 17 Research Natural Areas are described. Included are maps, photographs, and brief accounts of administration, climate, physiography, geology, soils, vegetation, fauna, research uses, and references. Threats and intrusions are noted.

This information should be useful to scientists interested in conducting botanical or zoological research in New Mexico.

Keywords: Research Natural Areas, New Mexico

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Keywords: Research Natural Areas, New Mexico

Rocky
Mountains

Southwest

Great
Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526